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John Hetherington & Sons,

Limited,

MAKERS OF ALL KINDS OF

COTTON OPENING, SCUTCHING,

CARDING, PREPARING,

SPINNING AND DOUBLING

MACHINERY.

John Hetherington & Sons, Ltd.

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128 DEVONSHIRE STREET, - BOSTON.

ALSO

ENGINEERS' TOOLS, MILL GEARING,

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HARRY LOCKETT, PRINTER, HANLEY.

RULES AND INSTRUCTIONS

including all necessary "Constants" for arriving at various calculations connected with the Cotton Opening, Carding, Preparing, and Spinning Machinery, as made by

JOHN HETHERINGTON & SONS, Ltd.,

Vulcan, Phœnix & Ancoats Works,

MANCHESTER.

INTRODUCTION.

The accompanying work, which has been specially compiled by us for the use of Managers, Carders, and Overlookers is, although small, both full and comprehensive, so far as the details of which it treats are concerned, and we venture to express a hope that the data therein given, being in a form which can be readily referred to, will be found extremely useful to all connected with cotton spinning, but more especially so where our make of machinery is employed.

UMass Dartmouth

John Hetherington & Sons, Limited,

Vulcan, Phœnix, and Ancoats Works.

COTTON.

THE chief contributors to the European supply are, in the order of their importance, as follows:—The United States, India, Egypt, Brazil, and Peru. Besides the cottons indigenous to most of these countries, nearly all produce different varieties, generally grown from seed of the most popular kinds cultivated in the United States. The following are those usually quoted in the Liverpool Cotton Brokers' Circular; to them are appended brief descriptions of their important characteristics—

Length of Staple,	Smoothness,
Fineness,	Colour, and
Strength,	Cleanliness.

American varieties are classed in four qualities—good ordinary, low middling, middling, and good middling; South American, three—middling fair, fair, and good fair; Egyptian, two—fair and good fair; East Indian, three—fair, good fair, and good. Standard samples of these classes are preserved for reference, in case of dispute, in the offices of the Liverpool Cotton Brokers' Association; and it is customary amongst brokers to form a set of the classes in which they deal, and, after careful comparison with the standards, to preserve them for easy reference when required. As, however, the crop of each succeeding year differs in some important respect from its predecessor, these standard samples are subject to considerable modification. According to the relative abundance or scarcity, fulness or deficiency, of special characteristics, the different varieties are classed up or down, as the case may require. Thus, within a limited range, there is a constant fluctuation of the standard.

A LIST OF COTTONS, AND THEIR ADAPTATION FOR SPINNING DIFFERENT NUMBERS OF YARN.

From the Lowest to the Highest Numbers.

Best Sea Island	.....	120's Upwards.
Best Egyptian, and the Shortest of Sea Island	.....	80's to 120's
Peeler (American) and Soft Egyptian	.....	60's to 80's
Orleans, Texas, and Soft Peruvian	These two classes are mixed together as the abundance or scarcity of each class prevails, but it is found that rough and smooth staples do not incorporate well, and hence do not make the best yarn.	40's to 60's
Pernams, Paraibas, Maranhams, Maceio, Rough Egyptian, and Rough Peru....		40's to 50's
Puerto Cabello (W.I.*) Surinam and Brazilian Peru	The lower classes of American are often mixed with these varieties; Georgia or Boweds, etc., mix best with Dhollerah, Broach, Oomrawuttee, etc., but stronger kinds are often used.	30's to 40's
La Guayran (W.I.), Ceara (B.†) and Aracaiju (B.).....		26's to 36's
Dhollerah, Dharwar, Broach, Oomrawuttee.....	The strong low classes of American are best adapted to mix with West Indian, Rough Brazilians, Smyrna, African, etc.	16's to 28's
Smyrna, African, Persian	.....	10's to 16's
Comptha, Bengal, Madras, Rangoon,..	.....	Very low Numbers

*West Indian. †Brazilian.

There are several varieties of cotton not named in this list that would mix with one or other of the above classes, but this must be left to the discretion of the person buying such cotton.

COMPARISON OF LENGTH OF STAPLE.

Country of Growth	Variety	Length of Staple			Mean Diam. of Fibre	Description
		Max.	Min.	Mean		
		In.	In.	In.	In.	
	Sea Island	1·80	1·60	1·70	1/1562	A fine, silky, regular cotton of several varieties, American being best
	Florida ditto	1·85	1·30	1·58	,,	
	Upland	1·20	1·00	1·10	1/1290	Soft and rather short in staple; usually clean, and best adapted for weft.
	Mobile	1·20	·90	1·05	,,	
	,,	1·20	·90	1·05	,,	
America...	Texas	1·00	·70	·85	,,	Firmer in staple than the above; but contains more leaf, and is less bright in appearance.
	,,	·95	·70	·82	,,	
	Orleans	1·20	1·00	1·10	,,	The best and most regular of all the American cottons. Some lots are very white, but leafy; others of a creamy tone, but clean.
	Pernams	1·50	1·20	1·35	1/1285	
	,,	1·40	1·10	1·25	,,	Pernams to Maranhams are Brazilian cottons, and, as a rule are harsh in staple, and give a wiry feel to the yarns into whose composition they enter.
	,,	1·30	·90	1·10	,,	
Brazil	Ceara Aracati, &c.	1·30	1·00	1·20	1/1300	
	Paraiba	1·30	1·10	1·20	..	
	Santos	...	...	...	..	
	Bahia	...	...	...	..	
	Aracaiju, &c.	...	...	...	..	
	Maceio	1·30	1·10	1·20	1/1270	
	Maranhams	1·30	1·00	1·15	,,	
		1·30	·90	1·10	,,	
Egypt...	Egyptian	1·60	1·40	1·50	1/1526	Brown Egyptian is soft and silky, whilst the white is usually hard and harsh.
	Gallini	1·50	1·20	1·35	1/1450	
	,, brown	...	...	1·30	1/1450	
	,, white	...	...	1·25	1/1300	
	Smyrna	...	...	...	..	Harsh in staple, and characterised by its irregularly-twisted fibres.
	Greek, &c.	...	...	...	..	Very irregular in staple.
	Fiji—Sea Island	1·90	1·25	1·70	1/1570	
	Tahiti—Sea Island	..	...	...	..	Fair in staple, but cannot be relied upon through successive seasons for uniformity of colour.
	West Indian	1·60	1·30	1·45	1/1300	
		1·40	1·20	1·30	,,	
		1·30	1·10	1·20	,,	
	Haytian	...	...	...	..	
	Laguayran	...	...	...	..	Exotic.
	,, Sea Island	...	...	...	..	Hard and soft varities. The soft assimilates with Orleans; the hard is best mixed with Brazilian
	Peruvian rough	...	...	1·28	1/1280	
	,, Soft Staple	...	...	...	..	Exotic.
	,, Sea Island	...	...	1·50	1/1450	Harsh stapled cotton, not of a bright colour.
	African	...	...	1·00	1/1200	
India ..	Surat	1·20	1·00	1·10	1/1185	The various classes under this head are fair working cottons, but the fibre is not so uniformly twisted as in Americans.
		1·20	·80	1·00	,,	
	Bengal	...	...	·80	1/1369	From Sea Island & Egyptian seed
	Rangoon	...	...	...	1/1185	Low in character, contains a large quantity of round and flat fibres
	Madras	...	...	·70	,,	

Cotton is valued according to the degree in which it possesses the special characteristics that best adapt it to the use for which it is intended.

ENGLISH COUNTS.

Table of Weights for Cotton Spinning.

24 Grains = 1 Pennyweight (Dwt.)
18 Dwts. + 5 grs. (or 437·5 grs.) = 1 Ounce.
16 Oz. (or 7,000 grs.) = 1 Pound.
1½ yards = 1 thread or round of Cotton reel.
120 ,, = 80 ,, = 1 skein, ley or lea.
840 ,, = 566 ,, = 7 skeins = 1 hank.

A bundle of cotton is as many hanks as makes 10 lbs. in weight.

The number of hanks in one pound is the count of cotton yarn.

The number of yards that weigh 8·33 grains is the number of the yarn.

The numbers by which sewing cotton threads are sold represent three threads of the number twisted together, that is No. 60 standard thread has three strands of No. 60 yarn in it.

In a six-cord thread each of the three strands is made up of two threads twisted together.

Six threads of No. 120 make six-cord 60.

Constant Number for a Dividend for a Number of Yards.

RULE. Take 12 for a divisor and divide as many hundreds as yards taken.

EXAMPLE. $\frac{1 \text{ yard} \times 100}{12} = 8{\cdot}3$ constant.

Yards	Dividends	Yards	Dividends	Yards	Dividends
1	8·33	6	50·	15	125·
2	16 66	7	58·33	20	166·
3	25·	8	66·66	30	250·
4	33·33	9	75·	40	333·33
5	41·66	10	83·33	60	500·

Counts of Different kinds of Yarns.

	Yds.		Yds.
Cotton is calculated by the hank of	840	Woollen Yorkshire Skein hank of	256
Worsted ,, ,, ,,	560	do. Dewsbury ,,	16
Spun Silk ,, ,, ,,	840	do. West of England ,,	320
Linen ,, ,, ,,	300	do. Galashiels (cut) ,,	300

Raw Silk (1000 yards per oz.)

Woollen Weights.

Huddersfield 16 Skeins = 16 yards to 1 dram.
Stirling lb. = 24 oz.
Galashiels (cut of) 12½ yds = 1 oz.
French No. 1s. = 31 yds. = 1 oz.
French Counts No. 1s. = 1000 metres = 1 kilo.

FRENCH COUNTS.

The *French* system of numbering is based on the metric system (one metre=39·37 inches), which is their standard of length, and the kilogram (one kilo=2·2047 pounds) is their standard weight; in numbering yarn accordingly a thread of cotton yarn 1,000 metres long, weighing 500 grammes (half a kilogram), is called No. 1.

No. 2 = 2,000 metres weighing 500 grammes.
,, 3 = 3,000 ,, ,, 500 ,,
,, 4 = 4,000 ,, ,, 500 ,,
,, 30 = 30,000 ,, ,, 500 ,,

This length of 1,000 metres is termed a hank (or écheveau) and each hank is divided into ten skeins (échevettes) of 100 metres each, these skeins are wrapped on a reel having a circumference of metres 1·425, making seventy revolutions.

It follows, from the above, that the count indicates the number of hanks required to weigh 500 grammes.

RULE.—Divide the metres reeled by twice the weight in grammes = counts French.

TO REDUCE FRENCH COUNTS TO ENGLISH multiply the French yarn No. × 1·18 = the English count sought.

TO REDUCE ENGLISH TO FRENCH Nos. divide the English counts by 1·18 = the French count sought.

Table giving the Comparative Numbers of English and French Counts.

English Counts	French Counts	English Counts	French Counts	English Counts	French Counts	English Counts	French Counts	English Counts	French Counts
1	0·847	17	14·40	46	38·96	78	66·07	150	127·05
2	1·693	18	15·25	48	40·66	80	67·76	160	135·52
3	2·540	19	16·09	50	42·35	82	69·45	170	143·99
4	3·388	20	16·94	52	44·04	84	71·15	180	152·46
5	4·235	22	18·63	54	45·74	86	72·84	190	160·93
6	5·082	24	20·33	56	47·43	88	74·54	200	169·40
7	5·929	26	22·02	58	49·13	90	76·23	210	177·87
8	6·776	28	23·72	60	50·82	92	77·92	220	186·34
9	7·623	30	25·41	62	52·51	94	79·62	230	194·81
10	8·470	32	27·10	64	54·21	96	81·31	240	203·28
11	9·313	34	28·80	66	55·90	98	83·01	250	211·75
12	10·16	36	30·49	68	57·60	100	84·70	260	220·22
13	11·01	38	32·19	70	59·29	110	93·17	270	228·69
14	11·86	40	33·88	72	60·98	120	101·64	280	237·16
15	12·70	42	35·57	74	62·68	130	110·11	290	245·63
16	13·55	44	37·27	76	64·37	140	118·58	300	254·10

Table giving the Comparative Numbers of French and English Counts.

French Counts	English Counts	French Counts	English Counts	French Counts	English Counts	French Counts	English Counts	French Counts	English Counts
1	1·18	17	20·1	46	54·3	78	92·—	150	177·—
2	2·36	18	21·2	48	56·6	80	94·4	160	189·—
3	3·54	19	22·4	50	59·—	82	96·8	170	201·—
4	4·72	20	23·6	52	61·4	84	99·2	180	212·—
5	5·90	22	26·—	54	63·7	86	101·5	190	224·—
6	7·08	24	28·3	56	66·1	88	103·8	200	236·—
7	8·26	26	30·7	58	68·4	90	106·2	210	247·8
8	9·44	28	33·—	60	70·8	92	108·6	220	260 —
9	10·6	30	35·4	62	73·1	94	110·9	230	271·4
10	11·8	32	37·8	64	75·5	96	113·2	240	283·—
11	13·—	34	40·1	66	77·9	98	115·6	250	295·—
12	14·2	36	42·5	68	80·2	100	118·—	260	307·—
13	15·3	38	44·8	70	82·6	110	130·—	270	318·6
14	16·5	40	47·2	72	84·9	120	141·6	280	330·—
15	17·7	42	49·6	74	87·3	130	153·—	290	342·2
16	18·9	44	51·9	76	89·7	140	165·—	300	354·—

French Measures and Weights Reduced to English.

LONG MEASURE.

Mètre = 3·28089 ft.
Décamètre (10 M.) = 32·8089 ft.
Kilomètre (1000 M.) = 1093·633 yds.
Myriamètre (10,000 M.) = 6·213 miles
Décimètre ($\frac{1}{10}$ M.) = 3·937 in.
Centimètre ($\frac{1}{100}$ M.) = 0·393 ,,
Millimètre ($\frac{1}{1000}$ M.) = 0·039 ,,

MEASURE OF CAPACITY.

Litre (1 cubic decimètre) = 1·760 pint.
Décalitre (10 litres) = 2·200 gals.
Hectolitre (100 litres) = 22·009 ,,
or 2·751 bushels.
Kilolitre, mètre cube (1000 litres) = 3·426 qrs.
Décilitre ($\frac{1}{10}$ of a litre) = 0·176 pint.
Centilitre ($\frac{1}{100}$ of a litre) = 0·017 ,,

SUPERFICIAL MEASURE.

Are (100 sq. mètres) = 0·098 rood
Hectare (10,000 square mètres) = 2·471 acres
Centiare (1 sq. mètre) = 1·196 sq. yd.

WEIGHTS.

Gramme (weight of 1 cubic centimètre of water in its state of maximum density, 39½ Fahr., or 4 degrees Centigrade) = 15·432 grains troy.
Décagramme (10 grammes) = 6·43 dwt.
Hectogram (100 grammes) = 3·527 oz. avoir., or 3·216 oz. troy.
Kilogramme (1000 grammes) = 2·205 lbs. avoir., or 2·680 lbs. troy.
Quintal mètrique (100 kilos.) = 220·54 lbs.
Millier (1000 kilos.) = 19 cwt. 12 oz. 5 dwt.
Décigram ($\frac{1}{10}$ gram) = 1·543 grain.
Centigram ($\frac{1}{100}$ gram.) = 0·15 grain.
Milligram ($\frac{1}{1000}$ gram.) = 0·015 grain.

THERMOMETER.

0° Centigrade (melting ice) = 32° Fahr.
100° ,, (boiling water) = 212° ,,
0° Réaumur (melting ice) = 32° ,,
80° ,, (boiling water) = 212° ,,

English Weights and Measures Reduced to French.

TROY WEIGHT.

Grain	=0·064 grammes
Pennyweight (24 grs.)	=1·555 ,,
Ounce (20 dwt.)	=31·103 ,,
Pound (12 oz.)	=0·373 kilogrammes

AVOIRDUPOIS WEIGHT.

Dram	=1·177 grammes
Ounce (16 dr.)	=28·349 ,,
Pound (16 oz.)	=0·453 kilogrammes
Quarter (28 lbs.)	=12·695 ,,
Hundredweight (112lbs)	=50·802 ,,
Ton (20 cwt.)	=1016·048 ,,

MEASURE OF CAPACITY.

Pint	=0·567 litres
Quart (2 pints)	=1·135 ,,
Gallon (4 quarts)	=4·543 ,,
Peck (2 gallons)	=9·086 ,,
Bushel (4 pecks)	=36·347 ,,
Sack	=1·090 hectolitres
Quarter (8 bushels)	=2·907 ,,
Load (5 quarters)	=14·539 ,,

LONG MEASURE.

1 Inch	=2·539 Centimètre
1 Foot	=30·479 ,,
3 Feet (1 yard)	=0·914 Mètres
Fathom (2 yards)	=1·828 ,,
Pole (5½ yards)	=5·029 ,,
Furlong (220 yards)	=201·164 ,,
Mile (1760 yards)	=1609·314 ,, or 1·609 kilomètres

SUPERFICIAL MEASURE.

Square inch	=6·451 Centimètres carrés
,, foot	=0·092 Mètres ,,
,, yard	=0·836 ,, ,,
Rod	=25·291 ,, ,,
Rood (1210 sq. yds.)	=10·116 Ares
Acre (4840 sq. yds.)	=40·467 ,,
Square mile	=2·588 Kilomètres carrés

SOLID MEASURE.

Cubic inch	=16·386 Centimetres cubes
,, foot	=0·028 Metre cube
,, yard	=0·764 ,, ,,

DECIMAL EQUIVALENTS OF FRACTIONS OF AN INCH.

	1/64 .01563		17/64 .26563		33/64 .51563		49/64 .76563
1/32	.03125	9/32	.28125	17/32	.53125	25/32	.78125
	3/64 .04688		19/64 .29688		35/64 .54688		51/64 .79688
1/16	.0625	5/16	.3125	9/16	.5625	13/16	.8125
	5/64 .07813		21/64 .32813		37/64 .57813		53/64 .82813
3/32	.09375	11/32	.34375	19/32	.59375	27/32	.84375
	7/64 .10938		23/64 .35938		39/64 .60938		55/64 .85938
1/8	.125	3/8	.375	5/8	.625	7/8	.875
	9/64 .14063		25/64 .39063		41/64 .64063		57/64 .89063
5/32	.15625	13/32	.40625	21/32	.65625	29/32	.90625
	11/64 .17188		27/64 .42188		43/64 .67188		59/64 .92188
3/16	.1875	7/16	.4375	11/16	.6875	15/16	.9375
	13/64 .20313		29/64 .45313		45/64 .70313		61/64 .95313
7/32	.21875	15/32	.46875	23/32	.71875	31/32	.96875
	15/64 .23438		31/64 .48438		47/64 .73438		63/64 .98438
1/4	.25	1/2	.5	3/4	.75	1	1.00000

EQUIVALENT VALUES OF MILLIMETRES AND INCHES.

Millimetres	Inches	Millimetres	Inches	Millimetres	Inches	Millimetres	Inches
1	·0394	27	1·0630	53	2·0866	79	3·1103
2	·0787	28	1·1024	54	2·1260	80	3·1496
3	·1181	29	1·1417	55	2·1654	81	3·1890
4	·1575	30	1·1811	56	2·2047	82	3·2284
5	·1968	31	1·2205	57	2·2441	83	3·2677
6	·2362	32	1·2598	58	2·2835	84	3·3071
7	·2756	33	1·2992	59	2·3228	85	3·3465
8	·3150	34	1·3386	60	2·3622	86	3·3859
9	·3543	35	1·3780	61	2·4016	87	3·4252
10	·3937	36	1·4173	62	2·4410	88	3·4646
11	·4331	37	1·4567	63	2·4803	89	3·5040
12	·4724	38	1·4961	64	2·5197	90	3·5433
13	·5118	39	1·5354	65	2·5591	91	3·5827
14	·5512	40	1·5748	66	2·5984	92	3·6221
15	·5906	41	1·6142	67	2·6378	93	3·6614
16	·6299	42	1·6536	68	2·6772	94	3·7008
17	·6693	43	1·6929	69	2·7166	95	3·7402
18	·7087	44	1·7323	70	2·7559	96	3·7796
19	·7480	45	1·7717	71	2·7953	97	3·8189
20	·7874	46	1·8110	72	2·8347	98	3·8583
21	·8268	47	1·8504	73	2·8740	99	3·8977
22	·8661	48	1·8898	74	2·9134	100	3·9370
23	·9055	49	1·9291	75	2·9528		
24	·9449	50	1·9685	76	2·9922	= 1 decimetre.	
25	·9843	51	2·0079	77	3·0315		
26	1·0236	52	2·0473	78	3·0709		

USEFUL MULTIPLIERS.

Feet ..	×	0·3048	= Metres.	Millimetres	×	0·03937	= Inches.
Inches ..	×	0 0254	= Metres.	Metres..	×	39·37	= Inches.
Inches ..	×	25·399	= Millimetres.	Metres..	×	3·281	= Feet.
Grains Troy	×	0·0648	= Grammes.	Grammes	×	15·432	= Grains Troy
Dwt. Troy	×	1·555	= Grammes.	Grammes	×	0·643	= Grains Troy
Pounds..	×	453 59	= Grammes.	Grammes	×	0·0022	= Pounds.

SQUARE ROOTS.

No.	Square Root	No.	Square Root	No.	Square Root	No.	Square Root	No.	Square Root
·0625	·25	21	4·582	66	8·124	111	10·535	156	12·490
·125	·355	22	4·690	67	8·185	112	10·583	157	12·529
·25	·5	23	4·795	68	8·246	113	10·630	158	12·569
·375	·61	24	4·898	69	8·306	114	10·677	159	12·609
·5	·71	25	5·0	70	8·366	115	10·723	160	12·649
·625	·79								
·75	·867	26	5·099	71	8·426	116	10·770	161	12·688
·875	·937	27	5·196	72	8·485	117	10·816	162	12·727
		28	5·291	73	8·544	118	10 862	163	12·767
1	1·0	29	5·385	74	8·602	119	10·908	164	12·806
1·125	1·061	30	5·477	75	8·660	120	10·954	165	12·845
1·25	1·119								
1·375	1·172	31	5·567	76	8·717	121	11·0	166	12·884
1·5	1·23	32	5·656	77	8·774	122	11·045	167	12·922
1·625	1·273	33	5·744	78	8·831	123	11·090	168	12·961
1·75	1·33	34	5·830	79	8·888	124	11·135	169	13·0
1·875	1·37	35	5·916	80	8·944	125	11·180	170	13·038
2	1·414	36	6·0	81	9·0	126	11·224	171	13·076
2·25	1·5	37	6·082	82	9·055	127	11·269	172	13·114
2·5	1·58	38	6·164	83	9·110	128	11·313	173	13·152
2·75	1·65	39	6·245	84	9·165	129	11·357	174	13·190
		40	6·324	85	9·219	130	11·401	175	13·228
3	1·732								
3·25	1·8	41	6·403	86	9·273	131	11·445	176	13·266
3·5	1·87	42	6·480	87	9·327	132	11·489	177	13·304
3·75	1·93	43	6·557	88	9·380	133	11·532	178	13·341
		44	6·633	89	9·433	134	11·575	179	13·379
4	2·0	45	6·708	90	9·486	135	11·618	180	13·416
4·25	2·06								
4·5	2·12	46	6·782	91	9·539	136	11·661	181	13·453
4·75	2·18	47	6·855	92	9·591	137	11·704	182	13·490
5	2·236	48	6·928	93	9 643	138	11·747	183	13 527
		49	7·0	94	9·695	139	11 789	184	13·564
6	2·449	50	7·071	95	9·746	140	11·832	185	13·601
7	2 645								
8	2·828	51	7·141	96	9·797	141	11·874	186	13·638
9	3·0	52	7·211	97	9·848	142	11·916	187	13·674
10	3·162	53	7·280	98	9·899	143	11·958	188	13·711
		54	7·348	99	9·949	144	12·0	189	13·747
11	3·316	55	7·416	100	10 0	145	12·041	190	13·784
12	3·464								
13	3·605	56	7·483	101	10·049	146	12 083	191	13·820
14	3·741	57	7·549	102	10 099	147	12·124	192	13·856
15	3·872	58	7·615	103	10·148	148	12 165	193	13·892
		59	7·681	104	10·198	149	12·206	194	13·928
16	4·0	60	7·745	105	10·246	150	12·247	195	13·964
17	4·123								
18	4·242	61	7·810	106	10·295	151	12·288	196	14·0
19	4·358	62	7·874	107	10 344	152	12·328	197	14·035
20	4·472	63	7·937	108	10·392	153	12 369	198	14·071
		64	8·8	109	10·440	154	12·409	190	14·106
		65	8·062	110	10·488	155	12·449	200	14·142

A SLUBBING AND ROVING TABLE.

TO TRY THE NUMBER OF HANKS BY PENNYWEIGHTS AND GRAINS, FROM ⅛ HANK TO 34 BY 5 YARDS, 15 YARDS, 30 AND 60 YARDS.

5 Yards		
Hanks	Dwts.	Grs.
⅛	13	21½
¼	6	22½
⅜	4	15
½	3	11¼
⅝	2	18½
¾	2	7½
⅞	1	23½
1	1	17½

15 Yards		
1	5	5
1⅛	4	15
1¼	4	4
1⅜	3	18¾
1½	3	11¼
1⅝	3	4¾
1¾	2	23½
1⅞	2	18½
2	2	14¼
2⅛	2	10½
2¼	2	7½
2⅜	2	4½
2½	2	2
2⅝	1	23½
2¾	1	21½
2⅞	1	19¾
3	1	17¼

30 Yards		
Hanks	Dwts.	Grs.
3	3	11
3⅛	3	8
3¼	3	4¾
3⅜	3	2
3½	2	23½
3⅝	2	20¾
3¾	2	18½
3⅞	2	16½
4	2	14½
4⅛	2	12½
4¼	2	10¾
4⅜	2	9
4½	2	7½
4⅝	2	6
4¾	2	4½
4⅞	2	3½
5	2	2
5¼	1	23½
5½	1	21¼
5¾	1	19¼
6	1	17½
6¼	1	16
6½	1	14¼
6¾	1	13
7	1	11½
7¼	1	10¼
7½	1	9¼
7¾	1	8½
8	1	7¼

60 Yards		
Hanks	Dwts.	Grs.
10	2	2
10¼	2	0¾
10½	1	23½
10¾	1	22½
11	1	21¼
11¼	1	20¼
11½	1	19¼
11¾	1	18½
12	1	17½
12¼	1	16¾
12½	1	16
12¾	1	15½
13	1	14¼
13½	1	13
14	1	11½
14½	1	10½
15	1	9¼
15½	1	8½
16	1	7¼
16½	1	6½
17	1	5¼
18	1	3¾
19	1	2¼
20	1	1
21	0	23¾
22	0	22½
23	0	21½
24	0	20¾
25	0	20
26	0	19
27	0	18½
28	0	17¾
29	0	17¼
30	0	16½
32	0	15½
34	0	14½

WEIGHT OF YARN OF DIFFERENT COUNTS FOR 1, 2, 3, 4, 5, 6, and 7 Leas.

1 Lea = 120 Yards = 80 Threads.

USEFUL FOR NUMBERING YARNS.

	1 Lea			2 Leas			3 Leas			4 Leas			5 Leas			6 Leas			7 Leas			
H'ks	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	H'ks
1	2	5	5,071	4½	1	7,267	6½	6	12,338	9	2	14,535	11	7	19,606	13½	3	21,801	16	0	0,000	1
2	1	2	14,535	2	5	5,071	3	7	19,606	4½	1	7,267	5½	3	21,803	6½	6	12,338	8	0	0,000	2
3	½	4	18,649	1½	0	10,422	2	5	5,071	3	0	20,845	3½	5	15,193	4½	1	7,275	5	6	1,924	3
4	½	1	7,268	1	2	14,536	1½	3	21,704	2	5	5,071	2½	6	12,339	3	7	19,607	4	0	0,000	4
5	0	8	8,114	½	7	13,353	1	6	18,592	1½	5	23,831	2	5	5,071	2½	4	10,310	3	3	15,549	5
6	0	6	22,762	½	4	18,649	1	2	14,536	1½	0	10,423	1½	7	9,185	2	5	5,071	2½	3	0,958	6
7	0	5	22,939	½	2	19,003	½	8	17,942	1	5	14,006	1½	2	10,070	1½	8	9,009	2	5	5,071	7
8	0	5	5,071	½	1	7,267	½	6	12,339	1	2	14,536	1	7	19,607	1½	3	21,804	2	0	0,000	8
9	0	4	15,174	½	0	3,474	½	4	18,649	1	0	6,948	1	4	22,123	1½	0	10,423	1½	5	1,597	9
10	0	4	4,057	0	8	8,114	½	3	9,296	½	7	13,354	1	2	14,536	1	6	18,593	1½	1	19,775	10
11	0	3	18,961	0	7	13,922	½	2	6,008	½	6	0,969	1	0	17,055	1	4	12,016	1	8	6,977	11
12	0	3	11,381	0	6	22,762	½	1	7,268	½	4	18,649	½	8	6,030	1	2	14,536	1	6	1,917	12
13	0	3	4,967	0	6	9,934	½	0	12,026	½	3	16,933	½	6	21,960	1	1	0,052	1	4	5,019	13
14	0	2	23,469	0	5	22,939	0	8	22,408	½	2	19,003	½	5	18,472	½	8	17,941	1	2	14,536	14
15	0	2	18,705	0	5	13,410	0	8	8,114	½	1	23,944	½	4	18,649	½	7	13,354	1	1	5,183	15
16	0	2	14,536	0	5	5,071	0	7	19,607	½	1	7,268	½	3	21 804	½	6	12,339	1	0	0,000	16
17	0	2	10,857	0	4	21,714	0	7	8,571	½	0	16,554	½	3	3,411	½	5	14,268	½	8	1,125	17
18	0	2	7,587	0	4	15,175	0	6	22,762	½	0	3,474	½	2	11,062	½	4	18,649	½	7	2,236	18
19	0	2	4,662	0	4	9,323	0	6	13,985	0	8	18,647	½	1	20,433	½	4	1,095	½	6	5,757	19
20	0	2	2,029	0	4	4,057	0	6	6,086	0	8	8,114	½	1	7,268	½	3	9,296	½	5	11,325	20
21	0	1	23,646	0	3	23,293	0	5	22,939	0	7	22,585	½	0	19,256	½	2	19,003	½	4	18,649	21
22	0	1	21,481	0	3	18,961	0	5	16,442	0	7	13,922	½	0	8,528	½	2	6,008	½	4	3,489	22
23	0	1	19,593	0	3	15,006	0	5	10,509	0	7	6,012	0	9	1,516	½	1	18,144	½	2	13,647	23
24	0	1	17,690	0	3	11,381	0	5	5,071	0	6	22,762	0	8	16,452	½	1	7,268	½	3	0,958	24
25	0	1	16,023	0	3	8,046	0	5	0,069	0	6	16,691	0	8	8,114	½	0	21,262	½	2	13,285	25
26	0	1	14,484	0	3	4,967	0	4	19,450	0	6	9,934	0	8	0,417	½	0	12,026	½	2	2,509	26
27	0	1	13,058	0	3	2,116	0	4	15,175	0	6	4,233	0	7	17,291	½	0	3,474	½	1	16,532	27
28	0	1	11,734	0	2	23,469	0	4	11,204	0	5	22,939	0	7	10,673	0	8	22,408	½	1	7,268	28
29	0	1	10,502	0	2	21,005	0	4	7,507	0	5	18,010	0	7	4,512	0	8	15,015	½	0	22,642	29
30	0	1	9,352	0	2	18,705	0	4	4,057	0	5	13,409	0	6	22,762	0	8	8,114	½	0	14,591	30
31	0	1	8,276	0	2	16,553	0	4	0,829	0	5	9,106	0	6	17,382	0	8	1,659	½	0	7,060	31
32	0	1	7,268	0	2	14,535	0	3	21,803	0	5	5,071	0	6	12,339	0	7	19,607	½	0	0,000	32
33	0	1	6,320	0	2	12,641	0	3	18,961	0	5	1,281	0	6	7,602	0	7	13,922	0	8	20,242	33
34	0	1	5,428	0	2	10,857	0	3	16,285	0	4	21,714	0	6	3,143	0	7	8,571	0	8	14,000	34
35	0	1	4,588	0	2	9,176	0	3	13,763	0	4	18,351	0	5	22,939	0	7	3,527	0	8	8,114	35
36	0	1	3,793	0	2	7,587	0	3	11,381	0	4	15,174	0	5	18,968	0	6	22,762	0	8	2,555	36
37	0	1	3,042	0	2	6,085	0	3	9,127	0	4	12,170	0	5	15,212	0	6	18,255	0	7	21,297	37
38	0	1	2,331	0	2	4,661	0	3	6,992	0	4	9,323	0	5	11,654	0	6	13,985	0	7	16,316	38
39	0	1	1,656	0	2	3,311	0	3	4,967	0	4	6,662	0	5	8,278	0	6	9,934	0	7	11,589	39
40	0	1	1,014	0	2	2,028	0	3	3,043	0	4	4,057	0	5	5,071	0	6	6,085	0	7	7,100	40
41	0	1	0,404	0	2	0,808	0	3	1,213	0	4	1,617	0	5	2,021	0	6	2,425	0	7	2,829	41
42	0	0	23,823	0	1	23,646	0	2	23,469	0	3	23,292	0	4	23,115	0	5	22,939	0	6	22,762	42
43	0	0	23,269	0	1	22,538	0	2	21,807	0	3	21,076	0	4	20,346	0	5	19,615	0	6	18,884	43
44	0	0	22,740	0	1	21,480	0	2	20,221	0	3	18,961	0	4	17,701	0	5	16,441	0	6	15,182	44
45	0	0	22,235	0	1	20,470	0	2	18,705	0	3	16,939	0	4	15,174	0	5	13,409	0	6	11,644	45
46	0	0	21,751	0	1	19,503	0	2	17,254	0	3	15,006	0	4	12,758	0	5	10,509	0	6	8,261	46
47	0	0	21,289	0	1	18,577	0	2	15,866	0	3	13,155	0	4	10,444	0	5	7,732	0	6	5,021	47
48	0	0	20,845	0	1	17,690	0	2	14,535	0	3	11,381	0	4	8,226	0	5	5,071	0	6	1,916	48
49	0	0	20,420	0	1	16,840	0	2	13,259	0	3	9,679	0	4	6,099	0	5	2,519	0	5	22,939	49
50	0	0	20,011	0	1	16,023	0	2	12,034	0	3	8,045	0	4	4,057	0	5	0,068	0	5	20,080	50

A

TO TRY
ANI

5

Hanks	D
$\frac{1}{8}$	
$\frac{1}{4}$	
$\frac{3}{8}$	
$\frac{1}{2}$	
$\frac{5}{8}$	
$\frac{3}{4}$	
$\frac{7}{8}$	
1	

15

1
$1\frac{1}{8}$
$1\frac{1}{4}$
$1\frac{3}{8}$
$1\frac{1}{2}$
$1\frac{5}{8}$
$1\frac{3}{4}$
$1\frac{7}{8}$
2
$2\frac{1}{8}$
$2\frac{1}{4}$
$2\frac{3}{8}$
$2\frac{1}{2}$
$2\frac{5}{8}$
$2\frac{3}{4}$
$2\frac{7}{8}$
3

TABLE OF THE WEIGHT OF YARN OF DIFFERENT COUNTS—*Continued.*

	1 Lea			2 Leas			3 Leas			4 Leas			5 Leas			6 Leas			7 Leas			
H'ks	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	H'ks
51	0	0	19,619	0	1	15,238	0	2	10,857	0	3	6,476	0	4	2,095	0	4	21,714	0	5	17,333	51
52	0	0	19,242	0	1	14,483	0	2	9,725	0	3	4,967	0	4	0,208	0	4	19,450	0	5	14,692	52
53	0	0	18,879	0	1	13,757	0	2	8,636	0	3	3,515	0	3	22,394	0	4	17,272	0	5	12,151	53
54	0	0	18,529	0	1	13,058	0	2	7,587	0	3	2,116	0	3	20,645	0	4	15,174	0	5	9,703	54
55	0	0	18,192	0	1	12,384	0	2	6,577	0	3	0,769	0	3	18,961	0	4	13,153	0	5	7,345	55
56	0	0	17,867	0	1	11,734	0	2	5,602	0	2	23,469	0	3	17.336	0	4	11,204	0	5	5,071	56
57	0	0	17,554	0	1	11,108	0	2	4,662	0	2	22,216	0	3	15,769	0	4	9,323	0	5	2,877	57
58	0	0	17,251	0	1	10,502	0	2	3,753	0	2	21,005	0	3	14,256	0	4	7,507	0	5	0.758	58
59	0	0	16,959	0	1	9,918	0	2	2,876	0	2	19,835	0	3	12,794	0	4	5,753	0	4	22,712	59
60	0	0	16,676	0	1	9,352	0	2	2,028	0	2	18,704	0	3	11,381	0	4	4,057	0	4	20,733	60
61	0	0	16,403	0	1	8,806	0	2	1,208	0	2	17,611	0	3	10,014	0	4	2,417	0	4	18,820	61
62	0	0	16,138	0	1	8,276	0	2	0,414	0	2	16,553	0	3	8,691	0	3	0.829	0	4	16,967	62
63	0	0	15,882	0	1	7,764	0	1	23,646	0	2	15,528	0	3	7,410	0	3	23,293	0	4	15,175	63
64	0	0	15,634	0	1	7,268	0	1	22,902	0	2	14,536	0	3	6,169	0	3	21,803	0	4	13,437	64
65	0	0	15,393	0	1	6,787	0	1	22,180	0	2	13,574	0	3	4,967	0	3	20,360	0	4	11,754	65
66	0	0	15,160	0	1	6,320	0	1	21,480	0	2	12,640	0	3	3,801	0	3	18,961	0	4	10,121	66
67	0	0	14,934	0	1	5,868	0	1	20,802	0	2	11,736	0	3	2,670	0	3	17,603	0	4	8.537	67
68	0	0	14,714	0	1	5,428	0	1	20,142	0	2	10,857	0	3	1,571	0	3	16,285	0	4	7,000	68
69	0	0	14,501	0	1	5,002	0	1	19,503	0	2	10,004	0	3	0,505	0	3	15,006	0	4	5,507	69
70	0	0	14,294	0	1	4,588	0	1	18,881	0	2	9,175	0	2	23,469	0	3	13,763	0	4	4,057	70
71	0	0	14.093	0	1	4,185	0	1	18,278	0	2	8,370	0	2	22,463	0	3	12,555	0	4	2,648	71
72	0	0	13,896	0	1	3,793	0	1	17,690	0	2	7,587	0	2	21.484	0	3	11,381	0	4	1,277	72
73	0	0	13,706	0	1	3,413	0	1	17,119	0	2	6,826	0	2	20,532	0	3	10,239	0	3	23.945	73
74	0	0	13,521	0	1	3,042	0	1	16,563	0	2	6,085	0	2	19,606	0	3	9,127	0	3	22,648	74
75	0	0	13,341	0	1	2,682	0	1	16,023	0	2	5,364	0	2	18,705	0	3	8,045	0	3	21,380	75
76	0	0	13,165	0	1	2,330	0	1	15,496	0	2	4,661	0	2	17,827	0	3	6,992	0	3	20,158	76
77	0	0	12,994	0	1	1,989	0	1	14,983	0	2	3,978	0	2	16,972	0	3	5,966	0	3	18,961	77
78	0	0	12,828	0	1	1,655	0	1	14,483	0	2	3,331	0	2	16,139	0	3	4,967	0	3	17,794	78
79	0	0	12,665	0	1	1,331	0	1	13,996	0	2	2,662	0	2	15,327	0	3	3,992	0	3	16,658	79
80	0	0	12,507	0	1	1,014	0	1	13,521	0	2	2,028	0	2	14,535	0	3	3,042	0	3	15,550	80
81	0	0	12,352	0	1	0,704	0	1	13,057	0	2	1,409	0	2	13,761	0	3	2,113	0	3	14.465	81
82	0	0	12,202	0	1	0,404	0	1	12,606	0	2	0,808	0	2	13,010	0	3	1,212	0	3	13,414	82
83	0	0	12,055	0	1	0,110	0	1	12,165	0	2	0,220	0	2	12,275	0	3	0.330	0	3	12,386	83
84	0	0	11,911	0	0	23,823	0	1	11,734	0	1	23,646	0	2	11.557	0	2	23,469	0	3	11,381	84
85	0	0	11,771	0	0	23,543	0	1	11,314	0	1	23,086	0	2	10,857	0	2	22,628	0	3	10,400	85
86	0	0	11,634	0	0	23,269	0	1	10,903	0	1	22,538	0	2	10,173	0	2	21,807	0	3	9,442	86
87	0	0	11,501	0	0	23,002	0	1	10,502	0	1	22,003	0	2	9,504	0	2	21,005	0	3	8,506	87
88	0	0	11,370	0	0	22,740	0	1	10,110	0	1	21,480	0	2	8,850	0	2	20,220	0	3	7,591	88
89	0	0	11,242	0	0	22,485	0	1	9,727	0	1	20,969	0	2	8,212	0	2	19,454	0	3	6,697	89
90	0	0	11,117	0	0	22,235	0	1	9,352	0	1	20,469	0	2	7,587	0	2	18,704	0	3	5,822	90
91	0	0	10,995	0	0	21,991	0	1	8,986	0	1	19,981	0	2	6,976	0	2	17,972	0	3	4,967	91
92	0	0	10,875	0	0	21,751	0	1	8,627	0	1	19,503	0	2	6,379	0	2	17,254	0	3	4,130	92
93	0	0	10,759	0	0	21,518	0	1	8,276	0	1	19,035	0	2	5,794	0	2	16,552	0	3	3,312	93
94	0	0	10,644	0	0	21,288	0	1	7,933	0	1	18,577	0	2	5,222	0	2	15,866	0	3	2,510	94
95	0	0	10,532	0	0	21,065	0	1	7,597	0	1	18,129	0	2	4,661	0	2	15,194	0	3	1,726	95
96	0	0	10,422	0	0	20,845	0	1	7,267	0	1	17,690	0	2	4,113	0	2	14,535	0	3	0,958	96
97	0	0	10,315	0	0	20,630	0	1	6,945	0	1	17,261	0	2	3,576	0	2	13,891	0	3	0,206	97
98	0	0	10,210	0	0	20,420	0	1	6,629	0	1	16,839	0	2	3,049	0	2	13,259	0	2	23,469	98
99	0	0	10,107	0	0	20,213	0	1	6,320	0	1	16,427	0	2	2,534	0	2	12,640	0	2	22,747	99
100	0	0	10,005	0	0	20,011	0	1	6,017	0	1	16,022	0	2	2,028	0	2	12,034	0	2	22,040	100
101	0	0	9,907	0	0	19,813	0	1	5,720	0	1	15,627	0	2	1,533	0	2	11,440	0	2	21,346	101
102	0	0	9,809	0	0	19,619	0	1	5,428	0	1	15,238	0	2	1,047	0	2	10,857	0	2	20,666	102
104	0	0	9,621	0	0	19,243	0	1	4,862	0	1	14,483	0	2	0,104	0	2	9 725	0	2	19,346	104
106	0	0	9,439	0	0	18,878	0	1	4,318	0	1	13,757	0	1	23,197	0	2	8,636	0	2	18,075	106
108	0	0	9,264	0	0	18,529	0	1	3,793	0	1	13,058	0	1	22,322	0	2	7,587	0	2	16,851	108
110	0	0	9,096	0	0	18,192	0	1	3,288	0	1	12,384	0	1	21,480	0	2	6.576	0	2	15,672	110
112	0	0	8,933	0	0	17,867	0	1	2,801	0	1	11,734	0	1	20,668	0	2	5,602	0	2	14,535	112

TO

Han

1/8 1/4 3/8 1/2 5/8 3/4 7/8 1

1 1 1/8 1 1/4 1 3/8 1 1/2 1 5/8 1 3/4 1 7/8 2 2 1/8 2 1/4 2 3/8 2 1/2 2 5/8 2 3/4 2 7/8 3

TABLE OF THE WEIGHT OF YARN OF DIFFERENT COUNTS—*Continued.*

	1 Lea	2 Leas	3 Leas	4 Leas	5 Leas	6 Leas	7 Leas	
H'ks	Oz. Dwt. Gr.	Oz. Dwt. Gr.	Oz. Dwt. Gr.	Oz. Dwt. Gr.	Oz. Dwt. Gr.	Oz. Dwt. Gr.	Oz. Dwt. Gr.	H'ks
114	0 0 8,777	0 0 17,554	0 1 2,331	0 1 11,108	0 1 19,884	0 2 4,661	0 2 13,438	114
116	0 0 8,625	0 0 17,251	0 1 1,876	0 1 10,502	0 1 19,128	0 2 3,753	0 2 12,379	116
118	0 0 8,479	0 0 16,959	0 1 1,438	0 1 9,917	0 1 18,397	0 2 2,876	0 2 11,356	118
120	0 0 8,338	0 0 16.676	0 1 1,014	0 1 9,352	0 1 17,690	0 2 2,028	0 2 10,366	120
122	0 0 8,201	0 0 16,403	0 1 0,604	0 1 8,805	0 1 17.007	0 2 1,208	0 2 9,410	122
124	0 0 8,069	0 0 16,138	0 1 0,207	0 1 8,276	0 1 16,345	0 2 0,414	0 2 8,483	124
126	0 0 7,941	0 0 15,882	0 0 23,823	0 1 7.764	0 1 15,705	0 1 23,646	0 2 7.587	126
128	0 0 7,817	0 0 15,634	0 0 23,451	0 1 7,268	0 1 15,084	0 1 22,901	0 2 6,718	128
130	0 0 7,696	0 0 15,393	0 0 23,090	0 1 6,787	0 1 14,483	0 1 22.180	0 2 5,877	130
135	0 0 7,412	0 0 14,823	0 0 22,235	0 1 5,646	0 1 13,058	0 1 20,470	0 2 3,881	135
140	0 0 7,147	0 0 14,294	0 0 21.440	0 1 4,587	0 1 11,734	0 1 18,881	0 2 2,028	140
145	0 0 6,900	0 0 13,800	0 0 20,700	0 1 3,600	0 1 10,500	0 1 17,400	0 2 0,300	145
150	0 0 6,670	0 0 13,341	0 0 20,011	0 1 2,682	0 1 9,352	0 1 16,022	0 1 22,693	150
155	0 0 6,455	0 0 12'910	0 0 19,365	0 1 1,820	0 1 8,275	0 1 14,730	0 1 21,185	155
160	0 0 6,253	0 0 12,506	0 0 18,759	0 1 1,012	0 1 7,265	0 1 13,518	0 1 19,771	160
165	0 0 6,063	0 0 12,126	0 0 18,189	0 1 0,252	0 1 6,315	0 1 12,378	0 1 18,441	165
170	0 0 5,885	0 0 11,770	0 0 17.655	0 0 23,540	0 1 5,425	0 1 11,310	0 1 17,195	170
175	0 0 5 717	0 0 11,434	0 0 17,151	0 0 22,868	0 1 4,585	0 1 10,302	0 1 16,019	175
180	0 0 5,558	0 0 11,116	0 0 16,674	0 0 22,234	0 1 3,790	0 1 9,348	0 1 14,906	180
185	0 0 5,408	0 0 10,816	0 0 16,224	0 0 21,632	0 1 3,040	0 1 8,448	0 1 13,856	185
190	0 0 5,266	0 0 10,532	0 0 15,798	0 0 21,064	0 1 2,330	0 1 7,596	0 1 12.862	190
195	0 0 5,130	0 0 10,260	0 0 15,390	0 0 20,520	0 1 1,650	0 1 6,780	0 1 11,910	195
200	0 0 5,002	0 0 10,004	0 0 15,006	0 0 20,008	0 1 1,010	0 1 6,012	0 1 11,014	200
205	0 0 4,880	0 0 9,760	0 0 14.640	0 0 19,520	0 1 0,400	0 1 5,280	0 1 10,160	205
210	0 0 4,764	0 0 9,528	0 0 14,292	0 0 19,056	0 0 23,820	0 1 4,584	0 1 9,348	210
215	0 0 4,653	0 0 9,306	0 0 13,959	0 0 18,612	0 0 23,265	0 1 3,918	0 1 8,571	215
220	0 0 4,547	0 0 9,094	0 0 13.641	0 0 18.188	0 0 22,735	0 1 3,282	0 1 7.829	220
225	0 0 4,446	0 0 8,892	0 0 13,338	0 0 17,784	0 0 22,230	0 1 2,676	0 1 7,122	225
230	0 0 4,350	0 0 8,700	0 0 13,050	0 0 17,400	0 0 21,750	0 1 2,100	0 1 6,450	230
235	0 0 4,257	0 0 8,514	0 0 12,771	0 0 17,028	0 0 21,285	0 1 1,542	0 1 5,799	235
240	0 0 4,164	0 0 8,328	0 0 12,492	0 0 16,656	0 0 20,820	0 1 0,824	0 1 5,148	240
245	0 0 4,083	0 0 8,166	0 0 12,249	0 0 16,332	0 0 20,415	0 1 0,498	0 1 4,581	245
250	0 0 4,002	0 0 8,004	0 0 12,006	0 0 16,008	0 0 20,010	0 1 0,012	0 1 4.014	250
255	0 0 3,923	0 0 7,846	0 0 11,769	0 0 15,692	0 0 19.615	0 0 23,538	0 1 3,461	255
260	0 0 3,848	0 0 7,696	0 0 11,544	0 0 15,392	0 0 19.240	0 0 23,088	0 1 2,936	260
265	0 0 3,775	0 0 7,550	0 0 11,325	0 0 15,100	0 0 18,875	0 0 22,650	0 1 2,425	265
270	0 0 3,706	0 0 7,412	0 0 11,118	0 0 14,824	0 0 18,530	0 0 22,236	0 1 1,942	270
275	0 0 3.638	0 0 7,276	0 0 10,914	0 0 14.552	0 0 18,190	0 0 21,828	0 1 1,466	275
280	0 0 3,573	0 0 7,146	0 0 10,719	0 0 14,292	0 0 17,865	0 0 21,438	0 1 1,011	280
285	0 0 3,510	0 0 7,020	0 0 10.530	0 0 14,040	0 0 17,550	0 0 21,060	0 1 0,570	285
290	0 0 3,450	0 0 6,900	0 0 10,350	0 0 13,800	0 0 17.250	0 0 20,700	0 1 0,150	290
295	0 0 3,391	0 0 6,782	0 0 10,173	0 0 13,564	0 0 16,955	0 0 20,346	0 0 23,737	295
300	0 0 3,335	0 0 6,670	0 0 10,005	0 0 13,341	0 0 16,675	0 0 20,010	0 0 23,345	300

CONVENIENT MULTIPLIERS.

Diameter of a circle × 3·1416 = the circumference.
Circumference of a circle × ·31831 = the diameter.
Diameter of a circle × ·8862 = the side of an equal square.
Side of a square × 1·128 = the diameter of an equal circle.
Square of diameter × ·7854 = the area of a circle.
Square root of area × 1·12837 = the diameter of equal circle.
Square of the diameter of a sphere × 3 1416 = convex surface.
Cube of ditto ·5236 = solidity.
Diameter of a sphere ·806 = dimension of equal cube.
Diameter of a sphere ·6667 = length of equal cylinder.
Square inches ·00695 = square feet.
Cubic inches ·000578 = cubic feet.
Cylindrical inches ·0004546 = cubic feet.
Cylindrical feet ·0290946 = cubic yards.
183,346 circular inches = 1 square foot.
2,200 cylindrical inches = 1 cubic foot.

Weights of Materials used in the Textile Industries.

Loads on Floors.

The following table gives the floor areas, storage capacity, weights of textile materials, &c., per cubic foot and per square foot. The gross weight of such packages are given.

Material	Measurements of Bale or Package		Weight in lbs.		
	Floor Space	Cubic feet	Gross	Per sq. foot	Per cubic foot
WOOL, COTTON, &c.—					
Bale, East India	3·0	12·0	340	113	28
,, Australia	5·8	26·6	385	66	15
,, South America	7·0	34·0	1000	143	29
Bag Wool	5·0	30·0	200	40	7
Heap of Scoured Wool	...	.....	....	....	5
Bale Cotton	8·1	44·2	515	64	12
,, Compressed	4·1	21·6	550	134	25
,, Jute	2·4	9·9	300	125	30
,, ,, Lashings	2·6	10·5	450	172	43
,, Manilla	3·2	10·9	280	88	26
,, Hemp	8·7	34·7	700	81	20
WOOLLEN GOODS—					
Case Flannels, heavy	7·1	15·2	330	46	22
,, Dress Goods	5·5	22·0	460	84	21
,, Underclothing	7·3	21·0	350	48	16
,, Blankets	10·3	35·0	450	44	13
,, Horse Blankets	4·0	14·0	250	63	18
COTTON GOODS—					
Piece Duck	1·1	2 3		68	33
Bale Brown Sheetings	3·6	10 1	235	65	23
Case Bleached Sheetings	4·8	11·4	330	69	30
Case Quilts	7·2	19·0	295	41	16
Bale Print Cloth	4·0	9·3	175	44	19
,, Tickings	3·3	8·8	325	99	37
Hanks Cotton Yarn	...	.....	....	....	11
Jute Bagging	1·4	5·3	100	70	24
BAGS IN BALES—					
Linen	8·5	39·5	910	107	23
White Cotton	9·2	40·0	715	78	18
Sacking	16·0	65·0	450	28	7
Woollen	7·5	30·0	600	80	20
Jute Butt	2·8	11·1	400	143	36
DYE STUFFS, &c.—					
Hogshead Bleaching Powder	11·8	39·2	1200	102	31
,, Soda Ash	10·8	29·2	1800	167	62
Box Indigo	3·0	9·0	385	128	43
,, Cutch	4·0	3·3	150	38	45
,, Sumac	1·6	4·1	160	100	39
Caustic Soda in Iron Drum	4·3	6·8	600	140	88
Barrel Starch	3·0	10·5	250	83	23
,, Alum	3·0	10·5	350	117	33
Box Extract Logwood	1·06	·8	55	52	70
MISCELLANEOUS—					
Newspaper	.....	.....	....	....	38
Straw Board	.....	.....	....	....	33
Writing Paper	.....	.....	....	....	64
Wrapping Paper	.....	.....	....	....	97
Bale of Hay	5·0	20·0	284	14	57
Tow, Dederick Compressed	1·75	5·25	150	86	29
Rope	.....	.....	....	....	42
Bale Leather	7·3	12·2	190	26	16
,, Raw Hides	6·0	30·0	400	67	13
,, ,, Compressed	6·0	30·0	700	117	23
,, Sole Leather	12·6	8·9	200	22	16

COTTON PREPARING & SPINNING MACHINERY: USEFUL NOTES AND FORMULÆ.

SCUTCHERS OR LAP MACHINES.

To find diameter of pulley on beater shaft.—Speed of beater × diameter of countershaft pulley for divisor. Revolutions of main driving shaft × diameter of driving drum on main shaft × drum on countershaft for dividend = pulley on beater shaft.

To find speed of fan when driven from beater.—Speed of beater × diameter of pulley on beater shaft ÷ diameter of pulley on fan shaft = speed of fan.

To find the pulley on fan shaft.—Speed of beater × diameter of pulley ÷ speed of fan = diameter of pulley.

To find the percentage of loss in cotton when passed through a scutcher.—Loss in weight × 100 ÷ weight of cotton put up at feed end = percentage of waste.

To find the length of a lap.—Weight of lap × 6 yds. ÷ weight of 6 yds of lap = length of lap.

CARDING ENGINES.

To find the draught between feed roller and doffer.—Wheel on side shaft × wheel on feed roller end × diameter of doffer ÷ bevel wheel on end of doffer × change pinion on end of side shaft × diameter of feed roller = draught required.

To find the draught between doffer and drawbox.—Wheel on end of doffer × drawbox shaft wheel × diameter of back roller ÷ drawbox back roller wheel × front shaft end wheel × diameter of doffer = draught required.

To find the draught in drawbox.—Diameter of front rollers × back roller wheel ÷ diameter of back roller × front roller wheel = draught required.

To find the length of 2 in. fillet to cover a card cylinder.—Diameter of cylinder × width of cylinder × 3·1416 ÷ width of fillet × 12 in. = feet required.

DRAWING FRAME.

To find the hank drawing.—Draught in drawing frame × hank carding ÷ number of ends put up at the frame = hank drawing.

To find the draught, given hank drawing and hank carding.—Number of ends put up × hank drawing ÷ hank carding = draught required.

To find the hank carding, given hank drawing and draught.—Number of ends put up × hank drawing ÷ draught = hank carding required.

DRAWING FRAME.—Continued.

To find weight of drawing, given draught, number of ends put up and weight of carding.—Number of ends × weight of carding ÷ draught = weight of drawing.

To find draught, given weight of drawing and carding.—Number of ends put up × weight of carding ÷ weight of drawing = draught required.

To find change pinion when changing from one weight to another.—Desired weight × change wheel at present on ÷ present weight of drawing = change pinion required.

To find change pinion when changing the hank.—Present pinion × present hank ÷ hank wanted = change pinion.

To find the draught in a drawing frame.—Back roller wheel × stud wheel × diameter of front roller ÷ change pinion × front roller wheel × diameter of back roller = draught required.

To find the draught between first and second rollers.—Wheel driven by front roller wheel × wheel on second roller × diameter of front roller ÷ diameter of second roller × by wheel that drives second roller × front roller wheel = draught required.

To find change pinion for a required draught.—Crown wheel × back roller wheel ÷ front roller wheel × draught = change pinion.

SLUBBING, INTERMEDIATE, AND ROVING FRAMES.

To find the speed of the spindles.—Speed of main shaft × diameter of pulley × shaft wheel on frame end × spindle shaft bevel wheel ÷ diameter of pulley on frame end × spindle shaft wheel × spindle foot wheel = speed of spindles.

To find speed of front roller.—Speed of main shaft × diameter of pulley × twist wheel × frame end cone shaft wheel ÷ pulley on frame end × cone shaft wheel × front roller wheel = speed of front roller.

To find the turns per inch.—Speed of spindles ÷ length delivered per minute = turns per inch.

To find the draught.—Diameter of front roller × back roller wheel × crown wheel ÷ diameter of back roller × change wheel × front roller wheel = draught.

To find the change wheel.—Crown wheel × back roller wheel × diameter of front roller ÷ diameter of back roller × front roller wheel × desired draught = change wheel required.

To find the constant number for the draught.—Diameter of front roller × back roller wheel × crown wheel ÷ diameter of back roller × front roller wheel = constant number.

SLUBBING, INTERMEDIATE, AND ROVING FRAMES.—Continued.

To find the hank slubbing.—The constant dividend for a given length ÷ the weight in grains of that given length = hank slubbing.

To find the change wheel when changing the hank.—Hank being made × change wheel on ÷ hank wanted = change wheel required.

To find the rack wheel when changing the hank.—The square of the rack wheel on × hank required ÷ hank being made; extract square root of quotient = rack wheel required.

To find the hank roving.—Same rule as used in finding the hank slubbing.

To find the length of a frame.—Number of spindles × gauge + gearing and off end, including pulley = length of frame.

RING SPINNING FRAME.

To find the dividend of any fraction of a hank.—Number of grains in 1 lb. × the fraction of a hank ÷ 840 yards = dividend for that fraction.

To find the speed of the spindles.—Diameter of tin roller × speed of tin roller ÷ diameter of spindle wharve = speed of spindles, less $7\frac{1}{2}$ per cent. for slipping.

To find the turns per inch.—Front roller wheel × large arm wheel × diameter of tin roller ÷ tin roller wheel × twist wheel × diameter of wharve × circumference of front roller = turns per inch.

To find the constant number for the twist.—Diameter of tin roller × large wheel × front roller wheel ÷ tin roller wheel × circumferenc of front roller × diameter of wharve = constant number.

To find the twist change pinion.—Constant number ÷ turns per inch = twist change pinion.

To find the draught.—Counts ÷ hank roving = draught.

To find the hank roving.—Counts ÷ draught = hank roving.

To find the counts.—Length of yarn ÷ weight in grains = counts.

To find the length of a ring frame.—Number of spindles on one side × gauge + space taken up by gearing and off end, including pulleys = length over all.

SELF-ACTING MULES.

To find the draught wheel.—Diameter of front roller × back roller wheel × crown wheel ÷ diameter of back roller × draught × front roller wheel = draught wheel.

SELF-ACTING MULES.—Continued.

To find the constant number.—Crown wheel × back roller wheel × diameter of front roller ÷ diameter of back roller × draught = constant number.

To find the draught.—Counts × length of stretch ÷ length delivered in inches × hank roving = draught required.

To find the counts of yarn.—Draught × hank roving × length of stretch ÷ length delivered in inches = counts of yarn.

To find the change pinion in changing counts.—Counts being spun × wheel on at present ÷ counts wanted = change pinion required.

To find the speed of the mule spindles.—Speed of rim shaft pulley × diameter of rim × diameter of tin roller ÷ pulley on tin roller shaft × diameter of spindle wharve = speed of spindles.

To find the turns per inch.—Speed of spindles ÷ speed of front roller × circumference of front roller = turns per inch.

To find the twist pulley when changing counts.—Square root of counts to be spun × twist pulley on mule ÷ square root of counts being spun = twist pulley.

To find the length of a mule.—Number of spindles × gauge + space taken up by headstock and two off ends = length of mule.

Width according to circumstances and length of stretch.

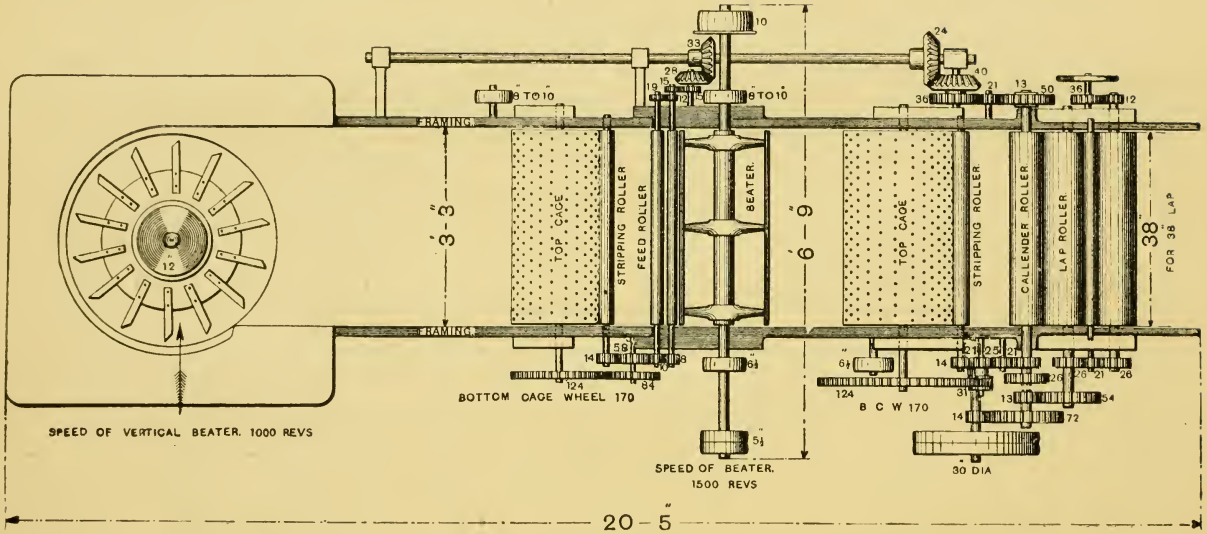
RING DOUBLING FRAME.

To find the speed of the spindle.—Diameter of tin roller × speed of tin roller ÷ diameter of spindle wharve = speed of spindles, less $7\frac{1}{2}$ per cent. for slipping.

To find the turns per inch.—Bottom roller wheel × wheel on top change stud × large wheel on bottom change stud × diameter of tin roller ÷ tin roller wheel × bottom twist wheel × top twist wheel × diameter of wharve × circumference of roller = turns per inch.

To find a constant number for twist.—Diameter of tin roller × large wheel on bottom change stud × wheel on top change stud × bottom roller wheel ÷ tin roller wheel × top change stud wheel × circumference of bottom roller × diameter of wharve = constant number.

To find the twist change pinion.—Constant number ÷ turn per inch = twist change pinion.



Plan of Combined Single Opener and Scutcher.

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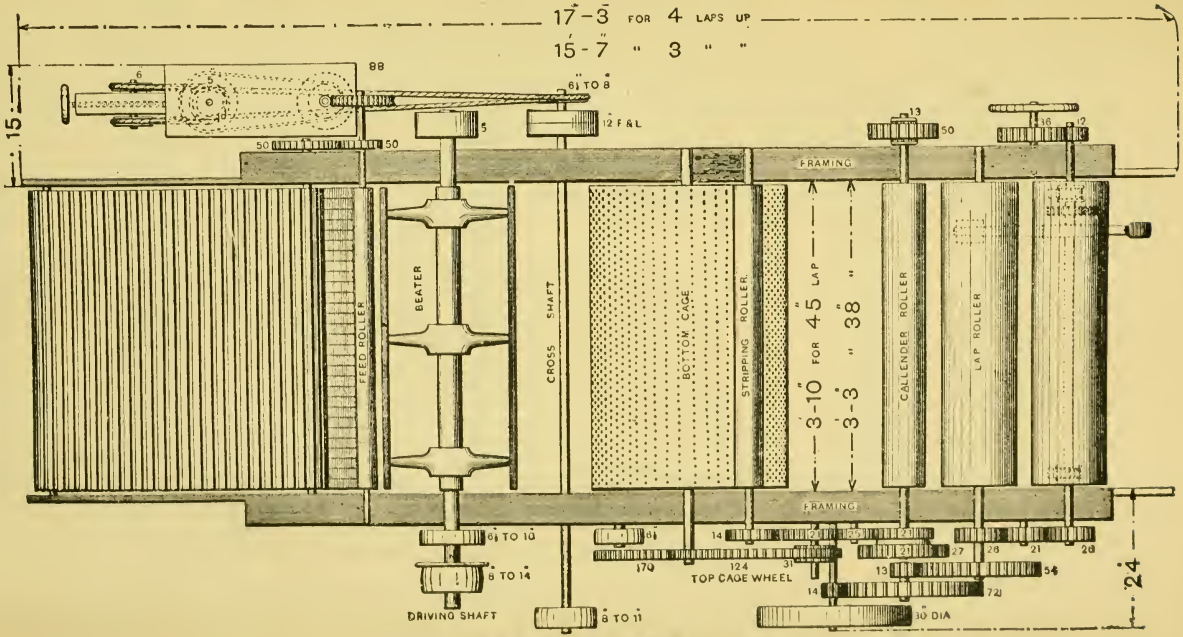

PLAN OF SINGLE BEATER SCUTCHER.

JOHN HETHERINGTON & SONS, LIMITED, MANCHESTER.

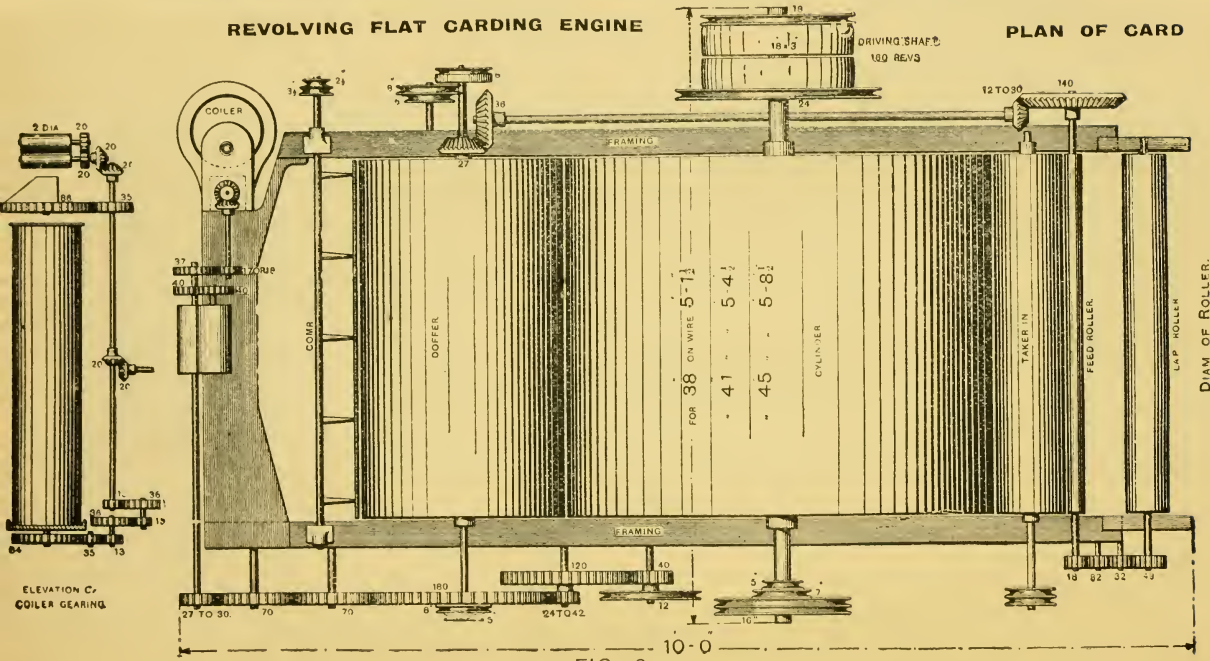

FIG. 9.

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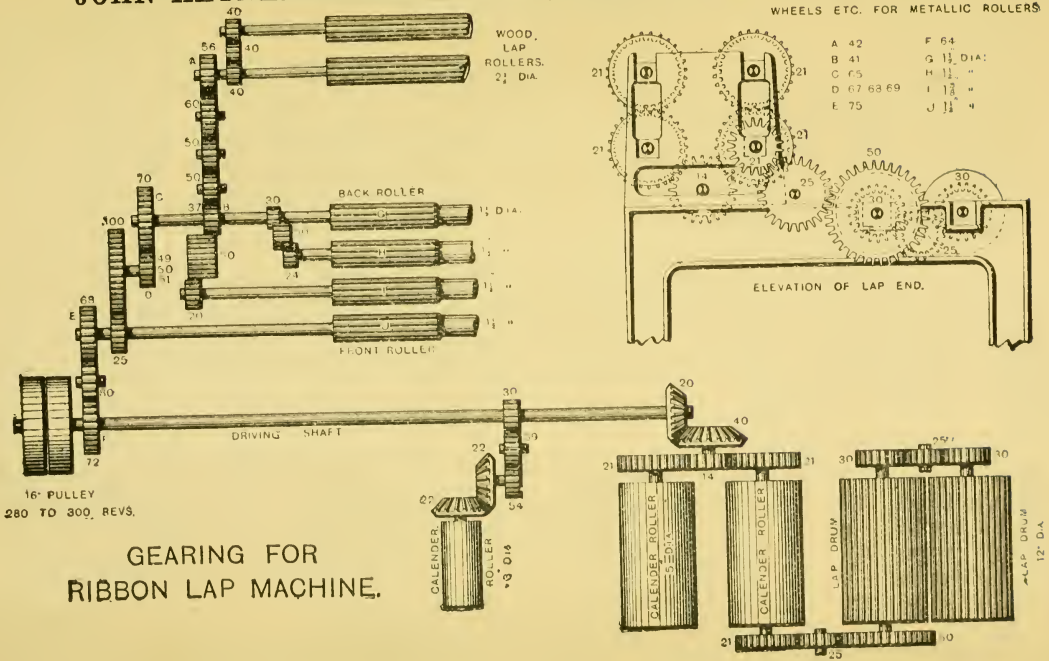
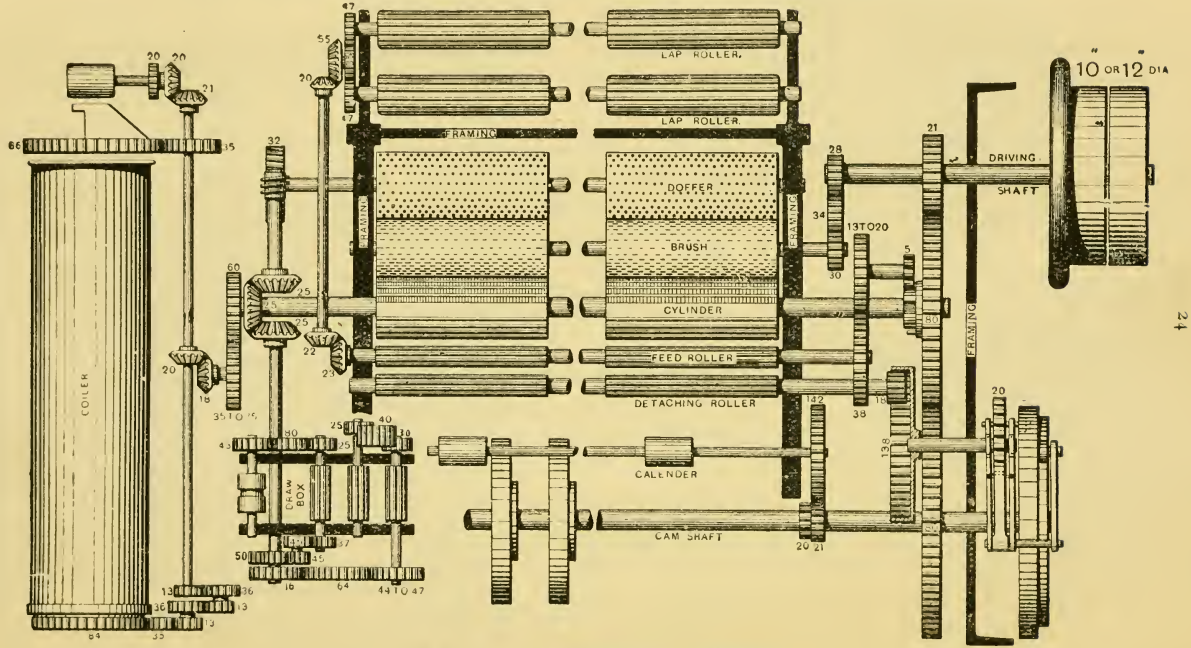
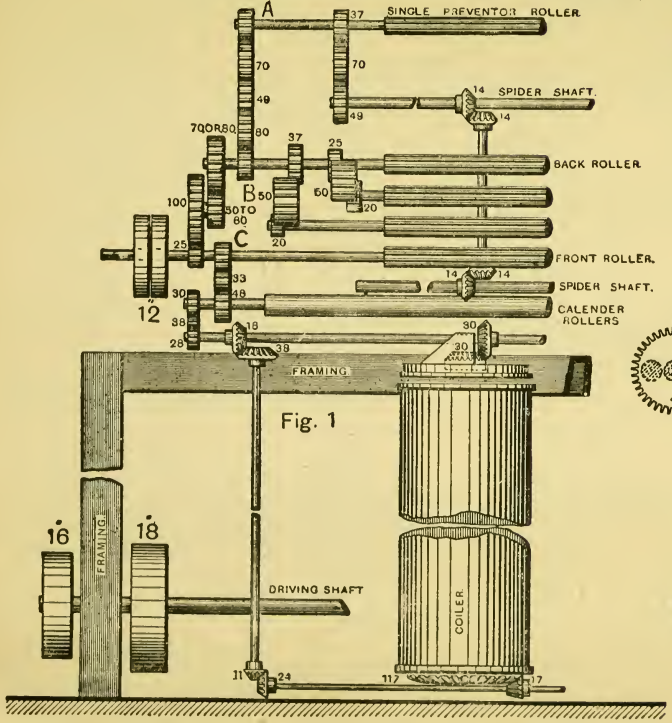


GEARING FOR RIBBON LAP MACHINE.



GEARING OF HEILMAN COMBER.

GEARING FOR DRAWING FRAMES.



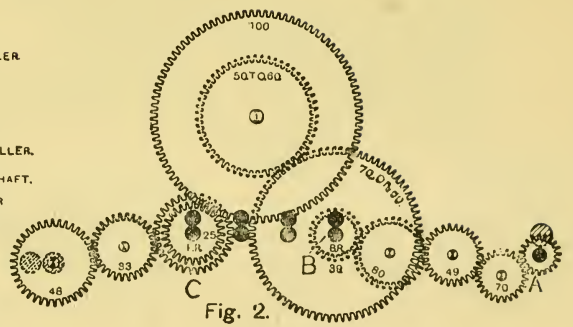


Fig. 2.

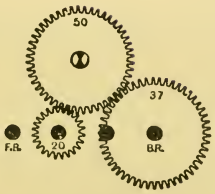


Fig. 3.

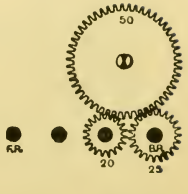
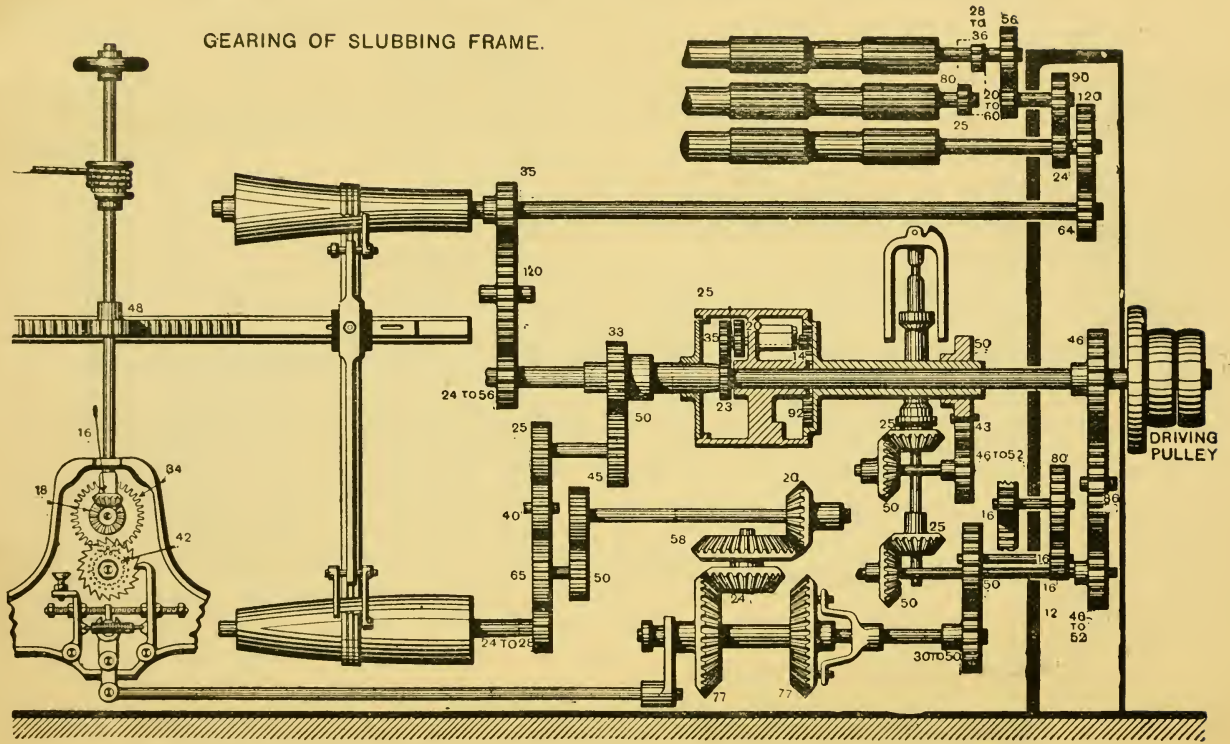


Fig. 4.

GEARING OF SLUBBING FRAME.



A.—46 for 19″, 48 for 19″, 20″ and 20½″ gauge, 48 for 17″ and 18″, 50 for 16″, 52 for 20″ gauge, 12″ lift.

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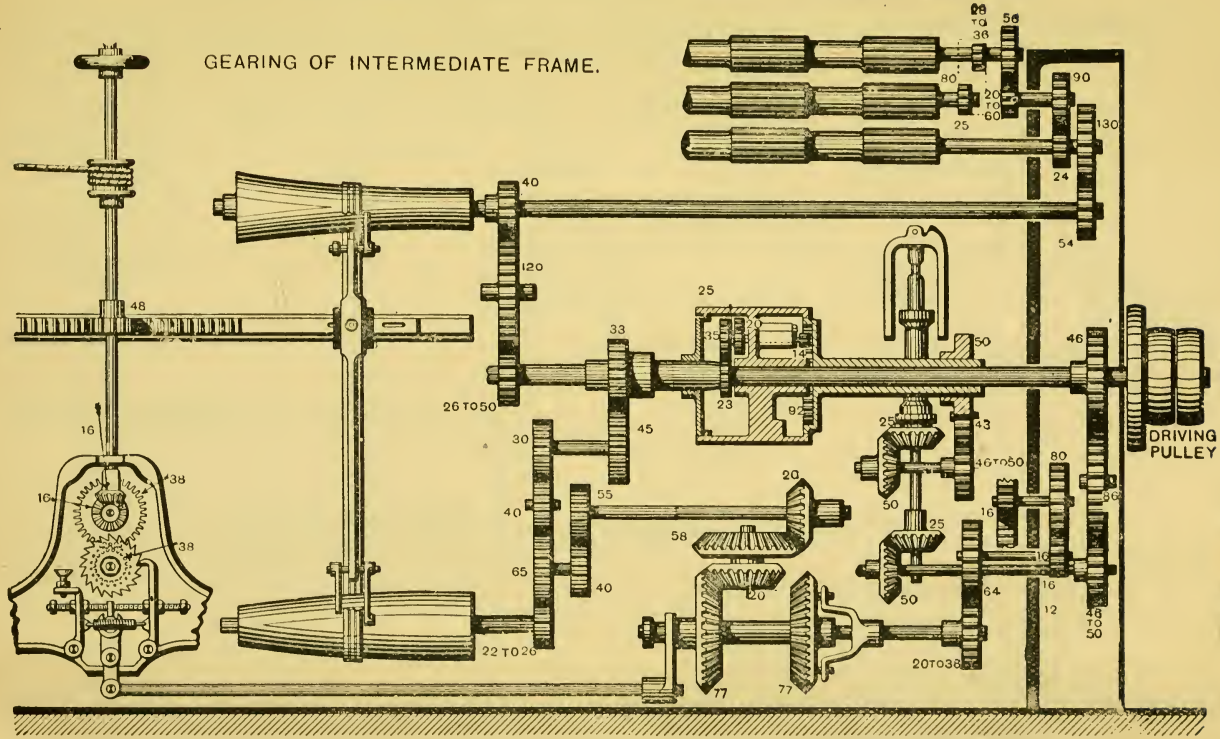
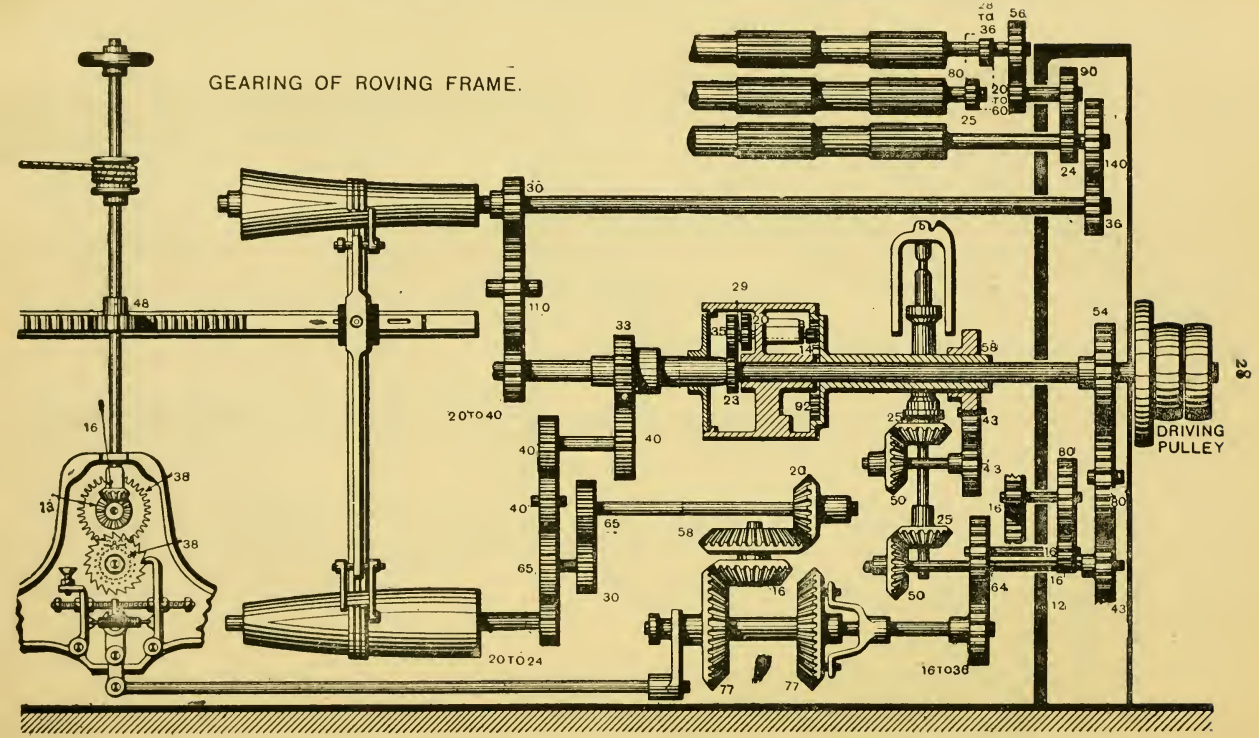
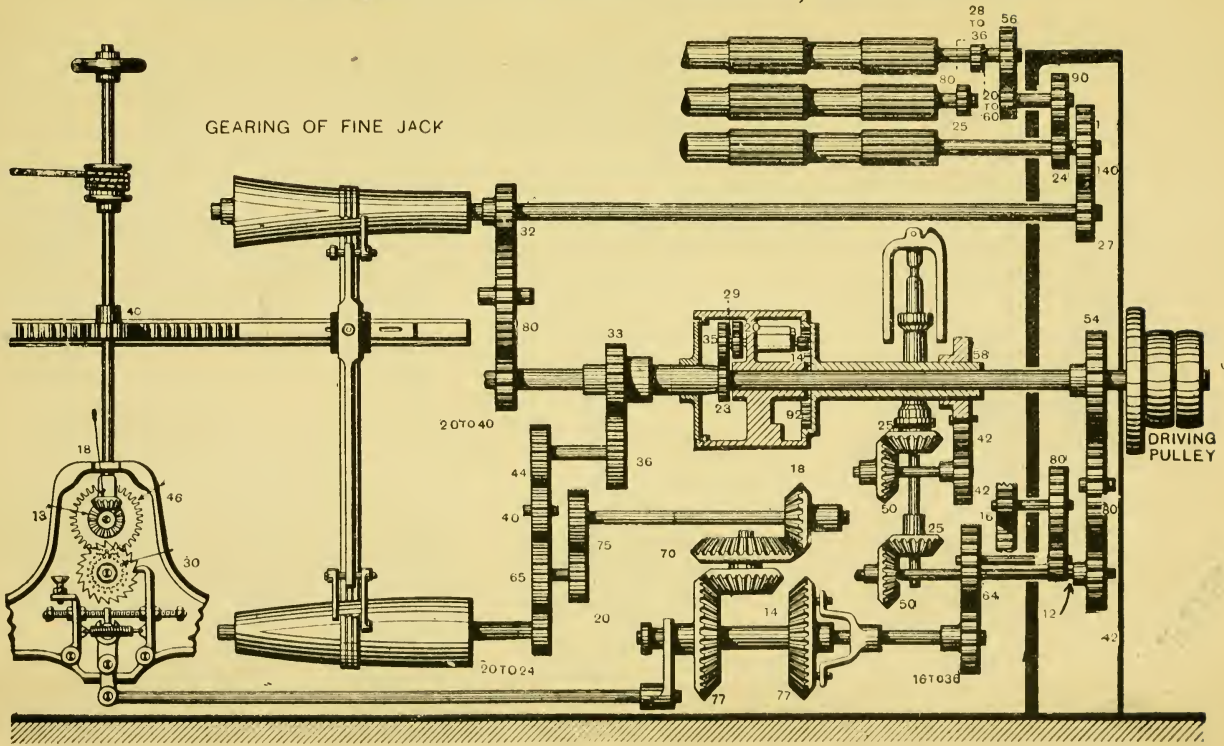


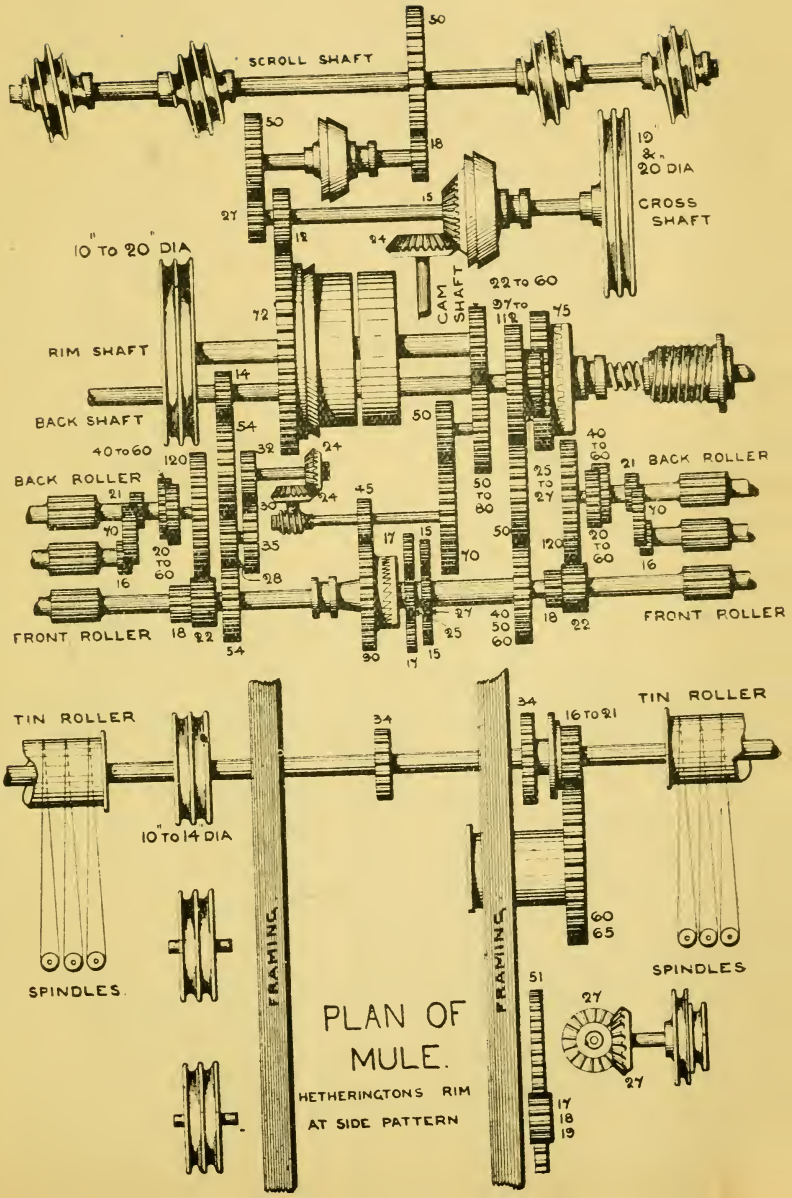
A.—43 for 18″, 44 for 18″ and 23″, 46 for 19″ and 25⅓″, 48 for 19″ and 25⅝″, 48 for 19¾″ and 26⅓″, 50 for 21″ gauge.



A.—42 for $17\frac{3}{16}$" and 18", 43 for $18\frac{1}{2}$", 20" and 21" gauges.

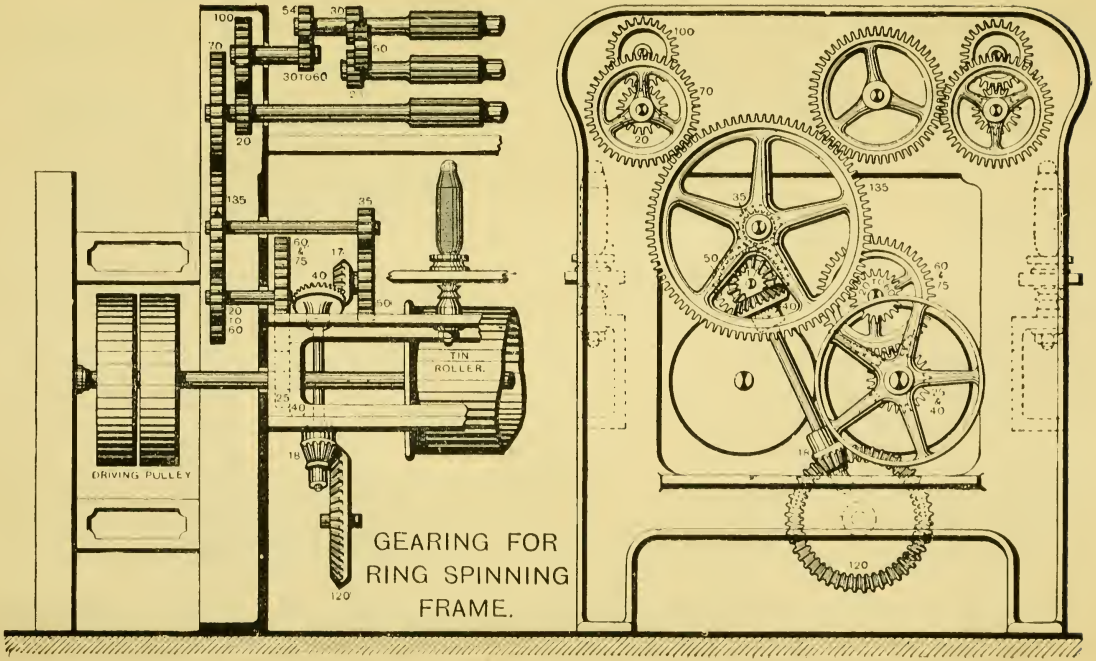

GEARING OF FINE JACK
28 TO 36
56
80
20 TO 60
25
90
1
24
140
27
32
80
40
29
33
35
58
54
23
92
20TO40
25
42
DRIVING PULLEY
18
36
44
40
65
75
70
18
50
25
42
16
80
30
64
12
20
14
50
42
18
46
13
30
20TO24
77
77
16TO36

CEARING OF, HETH MULE.

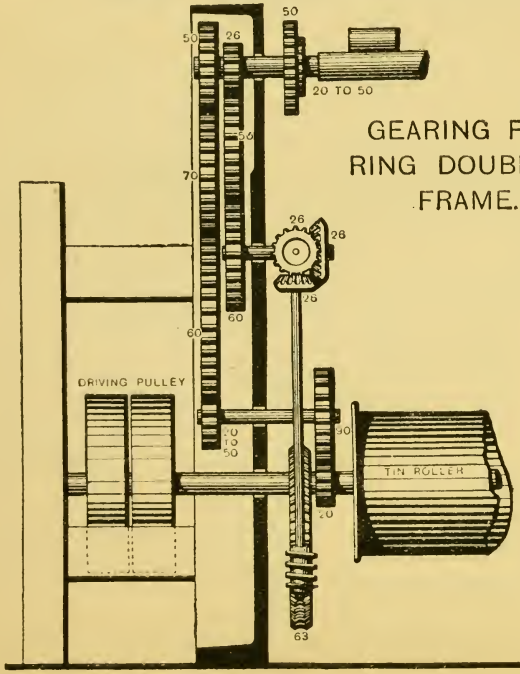

SCROLL SHAFT
50
50
18
19" & 20" DIA
CROSS SHAFT
27
15
12
24
CAM SHAFT
10" TO 20" DIA
22 TO 60
97 TO 112
72
75
RIM SHAFT
14
BACK SHAFT
54
50
40 TO 60
120
32
24
BACK ROLLER
21
30
24
45
50 TO 80
25 TO 27
40 TO 80
21
BACK ROLLER
70
70
20 TO 60
50
120
20 TO 60
16
35
17
15
70
16
28
27
40 50 60
18
22
FRONT ROLLER
18
22
54
30
17
25
15
FRONT ROLLER
TIN ROLLER
34
16 TO 21
TIN ROLLER
10" TO 14" DIA
FRAMING
FRAMING
60 65
SPINDLES
SPINDLES
51
27
27
17 18 19
PLAN OF MULE.
HETHERINGTONS RIM AT SIDE PATTERN

JOHN HETHERINGTON & SONS, LIMITED, MANCHESTER.

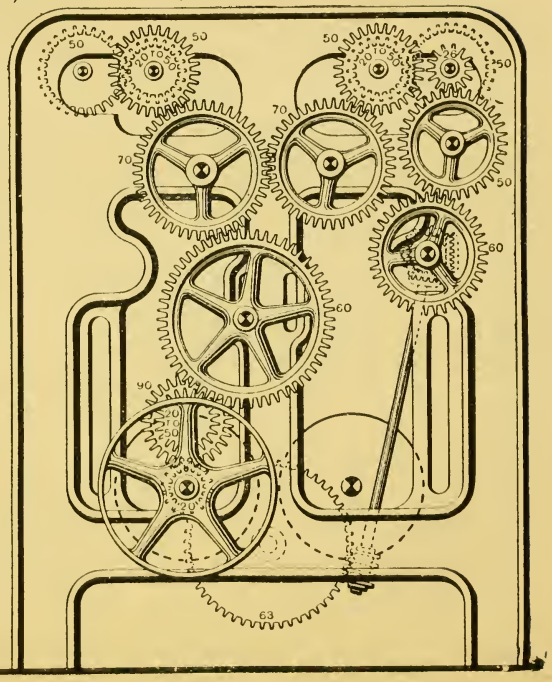
PLAN
OF
MULE
CURTIS PATTERN



GEARING FOR RING SPINNING FRAME.



GEARING FOR RING DOUBLING FRAME.



CALCULATIONS FOR "HETH" MACHINERY.

Constant for Draught and Card.

Feed Roller Wheel. Bevel on side shaft. Dia. of Doffer.

$$\frac{140}{x} \times \frac{36}{27} \times \frac{24{\cdot}75}{2{\cdot}25} = 2053 \text{ constant.}$$

Side shaft wheel (change). Bevel on doffer shaft. Diam. of feed roller.

Constant divided by draught gives change wheel.

Example.—2053 ÷ 100 draught. = 20's change wheel.

Feed Roller, $2\frac{1}{4}$ in. diameter for 38 in. and 41 in. cards.
" " $2\frac{1}{2}$ in. " 45 in. cards.

Draught and Counts.

The Draught that may be required in a card is determined by dividing the weight in grains of a yard of lap by the weight in grains of a yard of sliver, or by dividing the counts of sliver by the counts of the lap, and to do this as exactly as possible, it is well to reduce the actual weight or counts of the lays by about 5% for waste. Thus if a yard of lap weighs a pound (7,000 grains) or is 0·00119 hank, the weight should only be taken as 6650 grains, or the counts as 0·00125, and if a yard of the resulting sliver had to be $55\frac{1}{2}$ grains or 0·15 hank, the required draught would be 120. The draught is altered by changing the side shaft bevel, and the figures given below will be understood on reference to the small plan of the card annexed.

$$\frac{140}{\times} \times \frac{36}{27} \times \frac{180}{27 \text{ to } 31} \times \frac{4 \text{ in.}}{2\frac{1}{4} \text{ or } 2\frac{1}{2}} = \text{draught.}$$

Two Factors in the above train vary; the wheel on the end of the calender which depends on the kind of cotton worked, and the diameter of the feed roller, which is dependent on the width of the card, $2\frac{1}{4}$ in. being used for the 38 in. and 41 in. cards, and $2\frac{1}{2}$ in. roller for the 45 in. card.

Ribbon Lap Calculations.

The **WEIGHT** of the **LAPS** varies from 10 to 14 dwts. per yard according to the width and the quality of combing required. They may be made $7\frac{1}{2}$", $8\frac{3}{4}$", or $10\frac{1}{2}$" wide.

Draught.—The total draught in the machine is :—

$$\frac{56}{30} \times \frac{70}{\text{change wheel}} \times \frac{100}{25} \times \frac{68}{72} \times \frac{20}{40} \times \frac{14}{21} \times \frac{21}{50} \times \frac{12}{2{\cdot}75} \text{ in.} = \frac{301{\cdot}7}{\text{change wheel}}$$

The draught in the fluted roller is $\frac{280}{\text{change wheel}}$—if both back and front rollers are the same diameter.

Combing Machine Calculations.

Draught

Let **D** = the draught ; **F** = the feed wheel ; and **C** = the change wheel on the coiler cannon, the *total draught* between the lap rollers and the coiler top will be—

$$\mathbf{D} = \frac{47}{35} \times \frac{55}{20} \times \frac{22}{23} \times \frac{38}{\mathbf{F}} \times \frac{5}{1} \times \frac{60}{\mathbf{C}} \times \frac{20}{20} \times \frac{21}{20} \times \frac{2 \text{ in.}}{2{\cdot}75 \text{ in.}}$$

whence $\mathbf{D} = \frac{30753}{\mathbf{F} \times \mathbf{C}}$

The wheel **C** depends on the draught in the drawing head, and must be made to take up what the drawing head delivers.

The back roller wheel is altered when necessary so that the roller takes up the slivers from the table, and the draught in the drawing head is best altered by changing *only* the wheel on the outer end of the front roller, leaving the compound 45 and the 50 on the cross shaft unchanged.

If b = the back roller wheel, and f = the front roller wheel, the draught in the drawing head is $\frac{6 \times 3{\cdot}125}{f}$

C will then be $\frac{3 \times f}{2}$—and this will give a draught of 1·05 between the drawing head and the coiler top.

In estimating the weight of counts of the sliver, deduct the waste from the weight or counts of the lap, and consider all as going through then.

$$\text{Hank Sliver} \times \frac{\text{Hank of lap (reduced)} \times \text{draught.}}{\text{No. of laps up}}$$

$$\text{Or weight of Sliver} \times \frac{\text{Weight of lap, less waste} \times \text{No. laps up}}{\text{draught.}}$$

Constant for Draught in Drawing Frame Rollers.

Constant for 1½in. *front roller and* 1⅝in. *back roller and without single preventer roller.*

$$\frac{\text{Back roller wheel.}}{x} \times \frac{\text{Crown wheel.}}{25} \times \frac{\text{Diam. of front roller.}}{9} = 426 \text{ constant.}$$

Draught wheel (change). Front roller wheel. Diam. of back roller.

Constant for 1½in. *front roller with* 1¼in. *single preventer roller.*

$$\frac{\text{Wheel on single preventer roller.}}{39} \times \frac{\text{Back roller wheel.}}{x} \times \frac{\text{Crown wheel.}}{25} \times \frac{\text{Diam. of front roller.}}{10} = 335 \text{ constant.}$$

Wheel on back roller. Draught wheel (change). Front roller Wheel. Diam. of back roller.

The following table of constants for various combinations of sizes of front and back rollers has been calculated from the above data and that given in Fig. 1. Constants are given for the draught in the drawing rollers only, and also for the total draught, and in each case for a 70 and an 80 back roller wheel, one or other of these being put on according to the relation in the diams. of the front and back rollers.

$$\frac{\text{Constant}}{\text{Draught}} = \text{change wheel or} \quad \frac{\text{Constant}}{\text{change wheel}} = \text{draught}$$

The draught between the back roller and the 2nd and 3rd respectively is fixed for any particular machine, and any change made in the pinion only alters the draught between the front roller and the 2nd roller.

Diam. of Rollers		Constant for draught in the fluted Rollers only		Constant for total draught from the 1″ feed Roller to the 2″ calender	
		Back Roller Wheels		Back Roller Wheels	
Front	Back	70	80	70	80
1 1/16″	1 1/16″	280	320	306	350
1 1/16″	1 1/8″	264	302	284	325
1 1/8″	1 1/8″	280	320	304	347·5
1 1/8″	1 3/16″	252	288	276	316
1 1/4″	1 3/16″	311	356	326	373
1 1/4″	1 1/4″	280	320	296	338
1 3/4″	1 5/16″	254·6	291	268	305
1 5/8″	1 1/4″	342	391	357·5	408
1 5/8″	1 3/8″	308	352	328	372
1 5/8″	1 7/16″	280	320	292·5	334
1 7/8″	1 3/8″	373	427	389	445
1 7/8″	1 7/16″	336	384	354·5	405
1 7/8″	1 1/2″	305	349	318	364
1 1/2″	1 1/2″	280	320	292	334

THE FOLLOWING ARE ALSO USEFUL FORMULÆ FOR DRAWING FRAMES:—

$$\text{Hank drawing} = \frac{\text{Draught} \times \text{hank carding}}{\text{number of ends up}}$$

$$\text{Weight of drawing} = \frac{\text{Weight of carding by No. of ends up}}{\text{draught}}$$

$$\text{Draught} = \frac{\text{No. of ends up} \times \text{hank drawing}}{\text{hank carding}}$$

$$\text{Hank carding} = \frac{\text{No. of ends up} \times \text{hank drawing}}{\text{draught}}$$

$$\text{Change wheel} = \frac{\text{Desired weight} \times \text{change wheel on}}{\text{present weight}}$$

$$\text{or} = \frac{\text{Present hank} \times \text{change wheel on}}{\text{desired hank}}$$

Calculations for Slubbing, Intermediate, and Roving Frame Formulæ.

General Formulæ:

$$\text{Counts} = \frac{8\frac{1}{3} \times \text{length wrapped in yards}}{\text{weight of above length in grains}}$$

$$\text{Draught Wheel} = \frac{\text{Present counts} \times \text{wheel on}}{\text{required counts}}$$

$$\left.\begin{matrix}\text{Twist Wheel and} \\ \text{Lifter Wheel}\end{matrix}\right\} = \frac{\text{Square root of present counts} \times \text{wheel on}}{\text{square root of required counts}}$$

$$\text{Ratchet Wheel} = \frac{\text{Square root of required counts} \times \text{wheel on}}{\text{square root of present counts}}$$

$$\left.\begin{matrix}\text{Speed of} \\ \text{Driving Shaft}\end{matrix}\right\} = \frac{\text{Speed of line shaft} \times \text{diameter of pulley thereon}}{\text{diameter of pulley on frame}}$$

$$\text{Turns per inch} = \frac{\text{Speed of spindles in given time}}{\text{inches delivered in same time}}$$

$$\left.\begin{matrix}\text{Turns of Spindle for One} \\ \text{of the Driving Shaft}\end{matrix}\right\} = \frac{\text{Wheel on driving shaft} \times 50}{\text{wheel on spindle shaft} \times 25}$$

$$\left.\begin{matrix}\text{Inches Delivered by Front Roller for one turn of Driving Shaft}\end{matrix}\right\} = \frac{\text{twist wheel} \times \text{wheel on cone shaft end} \times 3{\cdot}14 \times f}{\text{top cone wheel} \times \text{wheel on front roller}}$$

NOTE.—f = diameter of front roller in inches and decimal of an inch.

Slubbing, Intermediate and Roving Frames. Twist Constants.

Constant for Twist per inch in SLUBBING FRAMES.

$$\frac{\text{Front roller wheel. } 120}{64\text{ Wheel on cone drum shaft.}} \times \frac{\text{Top cone wheel. } 35}{x\text{ Twist wheel.}} \times \frac{\text{Wheel on driving shaft. } 44}{44\text{ Wheel on spindle shaft.}} \times \frac{\text{Spindle wheel. } 50}{25\text{ Spindle toe wheel.}}$$

$$\times \frac{1}{\underset{\text{Circumference of front roller.}}{3{\cdot}92}} \text{ or } 1\tfrac{1}{4} \text{ front roller} = 33 \text{ constant.}$$

Constant divided by turns per inch = twist wheel.

In the following tables constants are given for the different gauges of frames, and for all required diameters of front rollers.

NOTE.—We have not given rollers of $1\frac{3}{16}$in. and $1\frac{5}{16}$in. diameter. Should constants for these be required they may be found by dividing the constants given opposite the 1in. roller in the various columns by 1·1875 and 1·3125 respectively.

SLUBBING FRAMES.

Diameter of the front roller	Usual 19in. 20in. $20\frac{1}{2}$in.	17in. 18in.	16in.	20in. for 12in. lift bobbins	Gauge
	46	48	50	52	Wheel on the end of the spindle shaft
	35	35	35	35	Top cone wheel
in.					
$\frac{7}{8}$	47·7	45·8	43 95	43·1	Multipliers for turns per inch
$\frac{15}{16}$	44·6	42·7	41	40·2	Sea Island $\sqrt{\text{counts}} \times$ ·7
1	41·8	40·05	38·45	37·7	Egyptian $\sqrt{\text{counts}} \times$ 1·0
$1\frac{1}{16}$	39·3	37·7	36·18	35·5	American $\sqrt{\text{counts}} \times$ 1·1
$1\frac{1}{8}$	37·15	35·6	34·18	33·5	Indian $\sqrt{\text{counts}} \times$ 1·3
$1\frac{1}{4}$	33·45	32·03	30·76	30·15	$\text{Change Wheel} = \frac{\text{constant}}{\text{required turns per inch}}$
$1\frac{3}{8}$	30·4	29·12	27·97	27·4	$\text{Turns per inch} = \frac{\text{constant}}{\text{twist wheel on}}$
$1\frac{1}{2}$	27·88	26·7	25·62	25·12	

INTERMEDIATE FRAMES.

Diameter of the front roller	18in. 23in.	19in. 25⅓in.	Usual 19⅔in. 26⅔in.	21in.	Gauge
	44	46	48	50	Wheel on the end of the spindle shaft
	40	40	40	40	Top cone wheel
in.					
⅞	73·45	70·15	66·2	64·55	Multipliers for turns per inch
15/16	68·6	65·45	62·5	60 2	Sea Island $\sqrt{\text{counts}} \times \cdot 8$
1	**64·13**	**61·35**	**58 6**	**56·45**	Egyptian $\sqrt{\text{counts}} \times 1{\cdot}1$
1 1/16	60·5	57·65	55·15	53·1	American $\sqrt{\text{counts}} \times 1{\cdot}15$
1⅛	57·15	54·55	52·1	50·2	Indian $\sqrt{\text{counts}} \times 1{\cdot}2$
1¼	57·4	49 1	46·9	45·15	*Change Wheel* = constant / required turns per inch
1⅜	46·75	44·6	42·6	41·0	Turns per inch = constant / twist wheel on
1½	42 85	40·9	39·08	37·6	

ROVING FRAMES.

Diameter of the front roller	17 5/16in. 18in.	18½in. 20in., 21in.	Gauge
	42	43	Wheel on the end of the spindle shaft
	30	30	Top cone wheel
in.			
⅞	109·3	106·75	Multipliers for turns per inch
15/16	97·4	99·6	Sea Island $\sqrt{\text{counts}} \times 1{\cdot}0$
1	**95·6**	**93·4**	Egyptian $\sqrt{\text{counts}} \times 1{\cdot}2$
1 1/16	89·95	87·9	American $\sqrt{\text{counts}} \times 1{\cdot}25$
1⅛	85	83	Indian $\sqrt{\text{counts}} \times 1{\cdot}35$
1¼	76·5	74 7	*Change Wheel* = constant / required turns per inch
1⅜	69·5	67·9	Turns per inch = constant / twist wheel on
1½	63·7	62·3	

FINE JACK FRAMES.

(27 on the end of cone shaft gearing with 140 on the front roller).

Diameter of the front roller	17 5/16in. 18in., 24in.		Gauge
	42		Wheel on the end of the spindle shaft
	45		Top cone wheel
in.			
1	191·3		Multipliers for turns per inch
1⅛	170		Sea Island $\sqrt{\text{counts}} \times 95$
1¼	153		Egyptian $\sqrt{\text{counts}} \times 1{\cdot}0$
1⅜	139		American $\sqrt{\text{counts}} \times 1{\cdot}1$
1½	127·5		*Change Wheel* = constant / required turns per inch

DRAUGHT WHEEL CONSTANTS.

CONSTANT FOR DRAUGHT IN SLUBBING FRAMES.

$$\frac{\text{Back roller wheel.}}{\text{Draught wheel.}} \times \frac{\text{Crown wheel.}}{\text{Front roller wheel.}} \times \frac{\text{Diam. of front roller.}}{\text{Diam. of back roller.}} = 281 \text{ constant.}$$

$$\frac{60}{x} \times \frac{90}{24} \times \frac{10}{8} = 281 \text{ constant.}$$

The above Constant is taken with $1\frac{1}{4}$ front roller and 1 back roller. Constant for $1\frac{1}{4}$in. front roller and $1\frac{1}{4}$in. back roller = 225 constant. Constant divided by draught = draught wheel.

In special cases the 56 back roller wheel is a 50 or a 60, and the front roller wheel sometimes 28. The table below gives constants for any of these combinations, and for all usual combination of roller diameters.

TABLE OF DRAUGHT CONSTANTS.

Diameter of Rollers		Front and Back Roller Wheels					
		USUAL	SPECIAL				
Front	Back	24 front 56 back	24 front 50 back	28 front 50 back	28 front 56 back	24 front 60 back	28 front 60 back
in.	in.						
$\frac{7}{8}$	1	184	164	141	157·5	196·8	168·7
$\frac{15}{16}$	1	197	175	151	168·6	210·8	180·6
1	1	210	187·5	160·8	180	225	192·8
$1\frac{1}{16}$	1	223	199	171	191	239	205
$1\frac{1}{16}$	$1\frac{1}{16}$	210	187·5	160·8	180	225	192·8
$1\frac{1}{8}$	1	236	211	181	202·5	253	217
$1\frac{1}{8}$	$1\frac{1}{8}$	210	187·5	160·8	180	225	192·8
$1\frac{1}{4}$	1	262·5	234·5	201	225	281	241
$1\frac{1}{4}$	$1\frac{1}{8}$	233	208	179	200	250	214
$1\frac{1}{4}$	$1\frac{1}{4}$	210	187·5	160·8	180	225	192·8
$1\frac{3}{8}$	$1\frac{1}{8}$	257	229	196	220	275	236
$1\frac{3}{8}$	$1\frac{1}{4}$	231	206	177	198	247·5	212
$1\frac{3}{8}$	$1\frac{3}{8}$	210	187·5	160·8	180	225	192·8
$1\frac{1}{2}$	$1\frac{1}{4}$	252	225	193	216	270	231·5
$1\frac{1}{2}$	$1\frac{3}{8}$	229	204·5	175·5	196·5	245·5	210·5
$1\frac{1}{2}$	$1\frac{1}{2}$	210	187·5	160·8	180	225	192·8

S.A. MULES.

A TABLE OF TURNS PER INCH

TO SPIN WEFT AND TWIST FROM 10'S TO 132'S.

Weft	Yarns	Weft	Yarns	Twist	Yarns	Twist	Yarns
Counts	Turns	Counts	Turns	Counts	Turns	Counts	Turns
10	10·27	72	27·57	10	11·85	72	31·81
12	11·25	74	27 96	12	12·95	74	32·25
14	12·16	76	28·33	14	14·03	76	32·68
16	13·00	78	28·70	16	15·00	78	33·11
18	13·76	80	29·07	18	15·91	80	33·54
20	14·53	82	29·43	20	16·77	82	23·95
22	15·24	84	29·79	22	17·59	84	34·36
24	15·92	86	30·14	24	18·37	86	34·77
26	16·57	88	30·49	26	19·12	88	35·17
28	17·20	90	30·83	28	19·84	90	35·57
30	17·80	92	31·17	30	20·54	92	35·96
32	18·38	94	31·51	32	21·21	94	36·35
34	18·95	96	31·84	34	21·87	96	36·74
36	19·50	98	32·17	36	22 50	98	37·12
38	20·03	100	32·50	38	23·12	100	37 49
40	20·55	102	32·82	40	23·72	102	37·87
42	21·06	104	33·14	42	24·30	104	38·24
44	21·56	106	33·46	44	24·87	106	38·60
46	22·04	108	33 77	46	25·43	108	38·97
48	22·52	110	34·08	48	25·98	110	39·33
50	22·98	112	34·39	50	26 52	112	39·68
52	23·44	114	34·70	52	27·04	114	40·03
54	23·88	116	35·00	54	27·56	116	40·38
56	24·32	118	35·30	56	28 06	118	40·73
58	24·75	120	35·60	58	28·56	120	41·07
60	25·17	122	35·89	60	29·05	122	41·42
62	25·59	124	36·19	62	29·52	124	41·75
64	26·00	126	36·48	64	30·00	126	42·08
66	26·40	128	36·77	66	30·46	128	42·42
68	26·80	130	37·05	68	30·92	130	42·75
70	27·19	132	37·34	70	31·37	132	43·08

Square root of Counts × by 3·25 Weft.

" " " × by 3·75 Twist.

TURNS OF SPINDLE TO ONE OF RIM.

Diameter of Rim Pulley	12in. Tin Roller Pulleys				14in. Tin Roller Pulleys		
	5in. Tin Roller and $\frac{3}{4}$in. Wharve	6in. Tin Roller and $\frac{3}{4}$in. Wharve	6in. Tin Roller and $\frac{7}{8}$in. Wharve	6in. Tin Roller and 1in. Wharve	6in. Tin Roller and $\frac{3}{4}$in. Wharve	6in. Tin Roller and $\frac{7}{8}$in. Wharve	6in. Tin Roller and 1in. Wharve
12	7·36	7·4	6·4	5 7	6·4	5·5	4·8
13	7·9	8·0	7·0	6·1	6·9	6·0	5·3
14	8·59	8·7	7·5	6 6	7·4	6·4	5·7
15	9·2	9·3	8·0	7·1	8·0	6 9	6·1
16	9·8	9·9	8·6	7·6	8·5	7·3	6·4
17	10·4	10·5	9·1	8·0	9·0	7·8	6·9
18	11·0	11·1	9·7	8·5	9·5	8·3	7·3
19	11 5	11·8	10·2	9·0	10·1	8·7	7·6
20	12·2	12·4	10·7	9·5	10·6	9·2	8 1

EXAMPLE.—To find turns of spindle to one of rim

$= 1\frac{2}{12}$in. $\times \frac{97}{13} = 7{\cdot}4$ Answer.

It will be seen from the above example that a 6in. Tin Roller has been taken, and a $\frac{3}{4}$in. wharve on spindle, with $\frac{1}{16}$in. added to each dimension for driving band.

Mule Twist Formulæ.

Constant for Twist for S.A. Mules. (Ordinary mule.)

Diam. of roller.				Front roller wheel.		Constant.		Change wheel.
$\frac{8}{8}$	×	$\frac{7}{22}$	×	$\frac{38}{17}$	×	$\frac{35}{28}$	×	$\frac{58^*}{x}$
Diam. of roller				Constant.		Constant.		Twist wheel.

Rim pulley. Diam. of tin cylinder.

$$\times \frac{18}{12} \times \frac{97}{13} = 577 \text{ constant.}$$

Tin roller pulleys. Diam. of wharve.

In all our make of mules we have two change places for twist. The above constant is with a 58s. wheel on second change.*

Constant with a 40s. wheel on second change* = 398.

The above calculation is with 18in. rim pulley, 12in. tin roller pulley, 6in. tin roller, and $\frac{3}{4}$in. wharve, with $\frac{1}{16}$in. added to tin roller and wharve for the diam. of band.

Constant for Twist for S.A. Mules. (Rim at side.)

Diam. of roller				Front roller wheel.		Constant.		Change wheel.
$\frac{8}{8}$	×	$\frac{7}{22}$	×	$\frac{90}{45}$	×	$\frac{70}{50}$	×	$\frac{70^*}{x}$
Diam. of roller.				Constant.		Constant.		Twist wheel.

Rim pulley. Diam. of tin cylinder.

$$\times \frac{18}{12} \times \frac{97}{13} = 698$$

Tin roller pulley. Diam. of wharve.

The above constant is with a 70s. on second change.*

Constant with a 50s. wheel on second change* = 498·5.

Constant divided by twist = twist wheel.

The following formulæ are useful in changing from one count to another :—

Twist wheel required (if a driving wheel) $= \frac{\text{sq. root of counts} \times \text{wheel on}}{\text{sq. root of counts required}}$

Twist wheel required (if a driven wheel) $= \frac{\text{sq. root of counts required} \times \text{wheel on}}{\text{sq. root of present counts}}$

Builder ratchet required $= \frac{\text{sq. root of required counts} \times \text{wheel on}}{\text{sq. root of present counts}}$

Mule Draught Formulæ.

On the front roller of the Hetherington mule is a compound wheel with 18 and 22 teeth, either of which may be used as required. The back roller wheel is usually 54, but may be any number from 40 to 60.

Constant for Draught in S.A. Mules. (Ordinary and rim at side.)

$$\underset{\text{Draught wheel.}}{\frac{\text{Back roller wheel}}{x}} \times \underset{\text{Front roller wheel.}}{\frac{\text{Crown Wheel.}}{18}} \times \frac{\text{Diam. of front roller.}}{\text{Diam. of back roller}} = \frac{54}{x} \times \frac{120}{18} \times \frac{1}{1} = 360 \text{ constant.}$$

The following table gives constants for various combinations of rollers, and with either 18 or 22 in gear:—

HETHERINGTON PATTERN.

Diameter: Front roller..	In. $\frac{13}{16}$	In. $\frac{13}{16}$	In. $\frac{13}{16}$	In. $\frac{1}{16}$	In. $\frac{7}{8}$	In. $\frac{7}{8}$	In. $\frac{7}{8}$	In. $\frac{15}{16}$	In. $\frac{15}{16}$	In. 1	In. $1\frac{1}{16}$	In. $1\frac{1}{8}$
Back roller ..	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$\frac{7}{8}$	$\frac{15}{16}$	1	$\frac{15}{16}$	1	1	1	1
Constant with 54 back and 22 front roller wheel	294·5	273	255	239	294·5	275	258	294·5	276	294·5	313	331
Constant with 54 back and 18 front roller wheel	360	334	312	292	360	336	315	360	337	360	382	405

If the back roller wheel be not 54, a new constant may be found by multiplying the foregoing by 54, and dividing by the other back roller wheel on.

H-PATTERN.

(Back roller wheel 50, Compound front roller wheel $\frac{16}{20}$.)

Diameter: Front roller..	In. $\frac{13}{16}$	In. $\frac{13}{16}$	In. $\frac{13}{16}$	In. $\frac{13}{16}$	In. $\frac{7}{8}$	In. $\frac{7}{8}$	In. $\frac{7}{8}$	In. $\frac{15}{16}$	In. $\frac{15}{16}$	In. 1	In. $1\frac{1}{16}$	In. $1\frac{1}{8}$
Back roller ..	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$\frac{7}{8}$	$\frac{15}{16}$	1	$\frac{15}{16}$	1	1	1	1
Constant with 50 back and 20 front roller wheel	300	278	260	244	300	280	262	300	281	300	319	337
Constant with 50 back and 16 front roller wheel	375	348	325	305	375	350	328	375	351	375	399	422

GAIN IN THE CARRIAGE.

The scrolls on the back shaft are made 5in. diameter, and for $\frac{5}{8}$in. scroll band. Their diameter to the centre of the band is therefore $5\frac{5}{8}$in. or 5·625.

The driving wheel on the front roller is either 40, 50, or 60, and three tables of constants are given below, one for each wheel.

The spur on the gain wheel gearing with the wheel on the back shaft is 25, 26, or 27, and in each table a line of constants for various sizes of front rollers is given opposite each of these wheels.

These constants divided by the draught between the carriage and the roller (that is the gain) will give the gain wheel.

Table I. 40 Front Roller Wheel.

Diameters of the Front Roller.

Spur on the Gain wheel	$\frac{7}{8}$in.	$1\frac{5}{16}$in.	1in.	$1\frac{1}{16}$in.	$1\frac{1}{8}$in.
25 ..	86·75	80	75	70·6	66 7
26 ..	89·2	83·2	78	73 4	69·35
27 ..	92 6	91·75	81	76·2	72

Table II. 50 Front Roller Wheel.

Diameters of the Front Roller.

Spur on the Gear wheel	$\frac{7}{8}$in.	$1\frac{5}{16}$in.	1in.	$1\frac{1}{16}$in.	$1\frac{1}{8}$in.
25 ..	107·2	100	93·75	88·25	83·4
26 ..	111·4	104	97 5	91·7	86·6
27 ..	115·3	107·8	101	95	89·8

Table III. 60 Front Roller Wheel.

Diameters of the Front Roller.

Spur on the Gain wheel	$\frac{7}{8}$in.	$1\frac{5}{16}$in.	1in.	$1\frac{1}{16}$in.	$1\frac{1}{8}$in.
25 ..	128 7	120	112·5	105·8	100
26 ..	133·8	124·8	117	110	104
27 ..	138 9	129·5	121 5	114	108

Example.—Suppose we require 3in. of gain in the carriage, that is 1·049 of a draught. We have 60 on the front roller which is 1in. in diameter, and we choose a gain wheel to have a 26 spur gearing with the back shaft wheel. In Table III, opposite 26 and below 1in., we find the constant 117, and dividing this by the required draught, 1·049, we get 112 nearly, that is a 112/26 gain wheel, for

$$\frac{60}{112} \times \frac{26}{75} \times \frac{5{\cdot}625\text{in.}}{1\text{in.}} = 1{\cdot}045,$$ or very nearly the draught required.

In our H-pattern the front roller wheel is always 45, and the gain wheel spur 18. The constants are therefore as follows:

Diameters of the Front Roller.

$\frac{7}{8}$in.	$1\frac{5}{16}$in.	1in.	$1\frac{1}{16}$in.	$1\frac{1}{8}$in.
103 ..	96·2 ..	90·2 ..	84·9 ..	80·2

These constants divided by the draught (gain) required will give the gain wheel.

RING THROSTLES.

In calculating the speed of spindles, add the thickness of the spindle band to the diameters of the tin roller and spindle wharves, and allowing $7\frac{1}{2}$ per cent. for slip, the result will be very approximately the actual speed.

$$\text{Speed of Spindles} = \frac{\text{speed of line shaft} \times \text{drum} \times \text{dia. of tin roller plus band}}{\text{pulley on the frame} \times \text{dia. of wharve plus band}}$$

$$\text{Draft} = \frac{\text{counts.}}{\text{hank roving.}}$$

Twist Constants for Spinning Frames.

On the tin roller shaft is a compound driving wheel with 25 and 40 teeth which gear respectively with 75 and 60 on the twist wheel stud. Either of these pairs may be used as desired.

Constant for Twist for Ring Throstles.

$$\frac{\text{Front roller wheel.}}{x} \times \frac{\text{Twist carrier wheel.}}{\text{Driving wheel.}} \times \frac{\text{Diam. of tin cylinder in } \frac{1}{8}\text{th.}}{\text{Diam. of wharve in } \frac{1}{8}\text{th.}} \times \frac{1}{\text{Circumference of 1in. roller.}} = 676{\cdot}8 \text{ constant.}$$

$$\frac{\text{Front roller wheel.}}{x} \times \frac{75}{25} \times \frac{81}{8} \times \frac{1}{3{\cdot}1416} = 676{\cdot}8 \text{ constant.}$$

Constant divided by turns per inch = twist wheel.

" " twist wheel = turns per inch.

The following table gives constants for both combinations with $\frac{3}{4}$in., $\frac{7}{8}$in. and 1in. spindle wharves and various diameter of rollers:—

Diam. of Spindle Wharve	Comp'nd combination wheel	Diameter of Front Rollers					
		$1\frac{3}{16}$in.	$\frac{7}{8}$in.	$\frac{15}{16}$in.	1in.	$1\frac{1}{16}$in.	$1\frac{1}{8}$in.
$\frac{3}{4}$in.	25/75	953	884	826	774	728	688
	40/60	476·5	442	413	387	364	344
$\frac{7}{8}$in.	25/75	834	775	723	678	638	602
	40/60	417	387·5	361·5	339	319	301
1in.	25/75	741	688	642	602	566	535
	40/60	370·5	344	321	301	283	267·5

$$\text{Twist wheel} = \frac{\text{constant}}{\text{turns per inch required.}}$$

$$\frac{\text{constant}}{\text{twist wheel on}} = \text{turns per inch given by that wheel.}$$

$$\text{Turns per inch for} \begin{cases} \text{ring twist} = \sqrt{\text{counts}} \times 4. \\ \text{ring weft} = \sqrt{\text{counts}} \times 3{\cdot}5. \end{cases}$$

Draught Constant.

Our usual arrangement is shown on the plan of gearing, namely, 20 on front roller driving 100 on change wheel stud, and 54 on the back roller.

CONSTANT FOR DRAUGHT FOR RING THROSTLES.

$$\frac{\text{Back roller wheel. } 54}{\text{Twist wheel. } x} \times \frac{\text{Crown wheel } 100}{\text{Front roller wheel. } 20} \times \frac{\text{Diam. of front roller. } 8}{\text{Diam. of back roller. } 8} = 270 \text{ constant.}$$

Constant divided by draught = draught wheel.
" " draught wheel = draught.

270 is therefore the draught constant if the front and back rollers are the same diameter, and the following table gives the constants for other combinations of rollers:—

	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
Diam. front roller ..	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{15}{16}$	$\frac{15}{16}$	1	$1\frac{1}{16}$	$1\frac{1}{8}$	$1\frac{1}{8}$
Diam. back " ..	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$\frac{7}{8}$	$\frac{15}{16}$	1	$\frac{15}{16}$	1	1	1	1	$1\frac{1}{8}$
Constant with 54 back roller wheel ..	270	251	234	219	270	252	236	270	253	270	287	304	270

Divide the constants by draught required to get necessary change wheel.

$$\text{Also } \frac{\text{constant}}{\text{change wheel on}} = \text{draught that wheel gives.}$$

Twist Constants for Doublers.

CONSTANT FOR TWIST FOR RING DOUBLER.
(Scotch System).

$$\frac{\text{Bottom roller wheel. } 50}{\text{Twist wheel (Top change). } 20} \times \frac{\text{Compound wheel. } 50}{\text{Twist wheel (Bottom change). } x} \times \frac{\text{Twist carrier wheel. } 90}{\text{Driving wheel. } 20} \times \frac{\text{Diam. of tin cylinder in } \frac{1}{8}\text{ths. } 81}{\text{Diam. of wharve. } 10}$$

$$\frac{1}{\text{Circumference of 1 in. roller.}} \times 3\cdot1416 \times \underbrace{2\tfrac{1}{8} \text{ in.}}_{\text{Diam. of roller.}} = 3625$$

The above constant is taken with $1\frac{1}{8}$ in. wharve and 10 in. tin cylinder, with $\frac{1}{8}$ in. added for the band to each dimension.

In all our make of ring doublers we have two change places, by means of which we can get any twist required. The above constant is taken with 20s. twist wheel on top change.

Constant with 50s. twist wheel on top change, with all conditions the same=1450.

Constant divided by turns per inch=twist wheel.

In our doubling frames two change places are provided for the twist, one on the stud of the wheel gearing with the tin roller wheel and the other wheel gearing with the wheel on the front roller. Calling the first X and the second Y—

$$\text{Turns per inch} = \frac{\text{Constant}}{\text{X multiplied by Y}}$$

$$X = \frac{\text{Constant}}{\text{Y multiplied by the required turns per inch.}}$$

$$Y = \frac{\text{Constant}}{\text{X multiplied by the required turns per inch.}}$$

Or, in words, assuming any suitable value for one wheel and multiplying it by the required turns per inch, the constant divided by the product thus obtained will give the other wheel.

The result will be more exact if 5 to 10 % be added to the required turns to allow for slip as the constants are based on the calculated speed of the spindle.

NOTES ON BELTING.

Co-efficient of friction between ordinary leather belting and cast-iron pulleys or drums = ·423. Ultimate strength of ordinary leather belting = 3086 lb. per square inch. Belts vary from $\frac{5}{16}$ in. to $\frac{1}{4}$ in. thick, average $\frac{7}{32}$ in.

Power of Single Leather Belts.—To calculate the power of single leather belts, the following formula may be used:—Let HP = actual horse-power. W = width of belt. F = driving force. T=working tension from 70 to 150 lbs. V = velocity of belt in feet per minute.

$$\text{Then } F = \frac{W \times T}{2}. \qquad HP = \frac{V \times F}{33{,}000}. \qquad W = \frac{33{,}000 \times HP}{F \times V}$$

Example.—A 10 in. belt running 2,500 ft. per minute, what horse-power will it transit? Assuming the working tension to be 100 lbs.,

$$F = \frac{10 \times 100}{2} = 500. \qquad HP = \frac{2{,}500 \times 500}{33{,}000} = 38 \text{ horse-power.}$$

Nystrom gives this rule:—$HP = \frac{V \times F}{550}$. V = velocity of belt in feet per second. F = force in pounds transmitted by belt.

The first rule gives good practical results where there is no great inequality in the diameter of the pulleys.

Harper's give the following short formula:—

Single belting	3	4	5	6	7	8	9	10	12	15	18 inches broad.
Will transmit	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{1}{4}$ horse-power.

for every 100 feet of velocity per minute.

Single belts transmit $\frac{2}{3}$ of the power of double belts.

Double belts transmit $1\frac{1}{2}$ times the power of single belts.

One belt placed upon the top of another will increase the drawing power by from 50 to 60 per cent., but they must not be fastened or connected together in any way.

Speed of Belts.—Belts have been employed running over 5000 ft. per minute Nothing, however, is gained by running belts much over 4,000 ft. per minute. About 3,500 ft. per minute for main belts agrees with good practice; lathe belts from 1,500 to 2,000 ft. per minute. The life of a belt may be prolonged and its driving powers increased by keeping it in good working order. To ensure this, it should be dressed on the back with castor oil every few weeks, more or less according to the dryness of the *atmosphere* in which it works.

MEDIUM WEIGHTS PER LINEAL FOOT OR STRAPPING.

Wid.	1 ft	2 ft.	3 ft.	4 ft.	5 ft.	10ft.	20ft.	30ft.	40ft.	50ft.	100ft.	200ft.	300ft.	500ft.
Ins.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
2	·19	·38	·57	·76	·95	1·9	3·8	5·7	7·6	9·5	19	38	57	95
$2\frac{1}{4}$	·22	·44	·66	·88	1·10	2·2	4·4	6·6	8·8	11·	22	44	66	110
$2\frac{1}{2}$	·25	·50	·75	1·	1·25	2·5	5·0	7·5	10 0	12·5	25	50	75	125
$2\frac{3}{4}$	·29	·58	·87	1·16	1·45	2·9	5·8	8·7	11·6	14·5	29	58	87	145
3	·33	·66	·99	1·32	1·65	3·3	6·6	9·9	13·2	16·5	33	66	99	165
$3\frac{1}{4}$	·37	·74	1·11	1·48	1·85	3·7	7·4	11·1	14·8	18·5	37	74	111	185
$3\frac{1}{2}$	·40	·80	1·20	1·60	2·0	4·0	8 0	12·	16·	20·	40	80	120	200
$3\frac{3}{4}$	·43	·86	1·29	1·72	2·15	4·3	8·6	12·9	17·2	21·5	43	86	129	215
4	·47	·94	1·41	1·88	2·35	4·7	9·4	14·1	18·8	23·5	47	94	141	235
$4\frac{1}{4}$	·50	1·0	1·50	2·	2.5	5·0	10·0	15·	20·0	25 0	50	100	150	250
$4\frac{1}{2}$	·54	1·08	1·62	2·16	2·7	5·4	10·8	16·2	21·6	27·	54	108	162	270
$4\frac{3}{4}$	·58	1·16	1·74	2·32	2·9	5·8	11·6	17·4	23·2	29·	58	116	174	290
5	·63	1·26	1·89	2·52	3·15	6·3	12·6	18·9	25·2	31·5	63	126	189	315
$5\frac{1}{4}$	·67	1·34	2·01	2·68	3·35	6·7	13·4	20·1	26·8	33 5	67	134	201	335
$5\frac{1}{2}$	·71	1·42	2·13	2·84	3·55	7·1	14·2	21·3	28·4	35·5	71	142	213	355
$5\frac{3}{4}$	·75	1·50	2·25	3·0	3·75	7·5	15·0	22·5	30·	37 5	75	150	225	375
6	·78	1·56	2·34	3·12	3·90	7·8	15·6	23·4	31·2	39·	78	156	234	390
7	·91	1·82	2·73	3·64	4·55	9·1	18·2	27 3	36·4	45·5	91	182	273	455
8	1·04	2·08	3·12	4·16	5·20	10·4	20·8	31·2	41 6	52	104	208	312	520
9	1·17	2·34	3·51	4·68	5·85	11·7	23·4	35·11	46·8	58·5	117	234	351	585
10	1·30	2·60	3·90	5·20	6·50	13·	26·0	39·	52·	65·	130	260	390	650

H. F. Cockhills' List.

NOTES ON ROPE DRIVING.

THE HORSE-POWER OF ROPES.—P driving force in lbs. $= c^2 \times x$. $x = 6$ to 10. c = circumference of rope. $HP = \frac{NPV}{33,000.}$ N = number of ropes on a pulley. V = velocity of rope in feet per minute.

Another rule.—HP = indicated horse-power. A = area of rope in inches. D = diameter of pulley in inches. R = revolutions per minute.

$$HP = \frac{A \times D \times R}{1,000.}$$

Another rule.—The area of the rope in inches × 1,000 ÷ 150 = the HP it is capable of transmitting at a speed of 1,000 feet per minute. For each 100 feet increase in speed add 6 per cent.

The HP transmitted by ropes varies directly as the square of the diameters.

The most efficient and economical speed for ropes doing good work is from 3,000 to 4,000 feet per minute.

Harpers' give the following short formula :—

One Rope	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2 inches diameter
will transmit	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{2}{5}$	$\frac{3}{5}$	$\frac{4}{5}$	1 horse-power

for every 100 ft. of velocity per minute.

The life of a rope is from three to five years.

The breaking strength of white or untarred ropes varies from 6,500 lb. to 1,150 lb. per square inch.

The working strength may be taken at $\frac{1}{6}$ to $\frac{1}{8}$, or from 800 lb. to 1,600 lb. per square inch. 1,200 lb. may be taken as a fair working strength. 140 lb. per square inch is common.

The Weight of ropes in lbs. per yard is approximately equal to the diameter of the rope in inches squared.

The co-efficient of friction of a rope working on a cast-iron pulley is 0·28; when working in a groove it is increased about three times, or from 0·57 to 0·84 for ungreased pulleys. If the pulleys are greased the co-efficient is reduced about one-half.

The diameter of a rope pulley should be at least 30 times greater than the diameter of the rope.

In piecing ropes the length of the splicing should be about 15 times the circumference of the rope.

DIAMETER OF ROPES, &c.

Diameter of rope	Circumference of rope	Area of rope	Net section of hawser-laid ropes	Weight per foot	Effective working tension	H.P. at speed of 1,000 ft. per minute	H.P. at speed of 5,000 ft. per minute	Smallest diameter of pulley measured at centre of rope
in.	in.	in.	in.	lb.	lb.			
$\frac{3}{4}$	2·35	·4417	·397	·184	55·5	1·68	8·4	22
1	3·141	·7854	·706	·33	98 8	2·99	14·9	30
$1\frac{1}{4}$	3·927	1·227	1·104	·51	154·5	4·68	23·4	37
$1\frac{1}{2}$	4·712	1·767	1·591	·74	222·7	6·75	33·75	45
$1\frac{3}{4}$	5·105	2·073	1·865	·88	261·0	8·0	44·0	48
$1\frac{1}{4}$	5·497	2·405	2·164	1·0	302·9	9·18	45 9	52
2	6·283	3·141	2·826	1·3	395 0	12·0	60·0	60

The pitch of the pulleys is the distance apart of the grooves from centre to centre. The diameter of the pulley is measured to the centre line of the ropes running round the pulley.

NOTES ON SHAFTING AND GEARING.

The strength of shaft are proportional to the cube of their diameters.

To find the power which wrought-iron shafting can transmit as first mover.

$$\frac{\text{The cube of the diameter} \times \text{revolutions per minute}}{100} = \text{H.P.}$$

NOTE.—As a second mover divide by 85 and 3rd mover by 70.

To find the power which steel shafting will transmit divide by 50.

Steel shafting will transmit from 1¾ to 2 times as much H.P. as wrought-iron shafting.

DIMENSIONS OF ORDINARY WROUGHT-IRON SHAFTING.

Revolutions per minute	Indicated Horse-power									
	10	20	30	40	50	60	70	80	90	100
10	4·02	5·06	5·80	6·38	6·87	7·31	7·69	8·04	8·36	8·66
20	3·21	4·02	4·60	5·06	5 46	5·8	6·11	6·38	6·64	6·87
30	2·8	3·53	4·02	4·43	4·77	5·06	5·35	5 58	5·8	6·01
40	2·57	3·17	3·66	4·02	4·34	4·61	4·85	5·06	5·28	5·46
50	2·35	2·96	3·39	3 73	4·02	4·27	4·5	4·70	4·89	5·06
60	2·22	2·8	3·21	3·53	3·80	4·02	4·23	4·43	4·61	4·77
70	2·15	2·67	3·04	3·36	3·61	3·82	4·02	4·22	4·38	4·53
80	2·04	2·57	2·92	3·21	3·45	3·66	3·85	4·02	4.20	4·34
90	2·	2·46	2·80	3·07	3·33	3·53	3 71	3·87	4·02	4·18
100	1·86	2·35	2 69	2·96	3·17	3·39	3·56	3·73	3·87	4·02
120	1·76	2 22	2·57	2·8	3·03	3·21	3 36	3·53	3·66	3·80
150	1·64	2·08	2 35	2·62	2·80	2·96	3·14	3·27	3·39	3·53
170	1·58	2·0	2·29	2·52	2·67	2·84	2·96	3·14	3·27	3·39
200	1·5	1·86	2·15	2·35	2·52	2·71	2 84	2·96	3·11	3·21
250	1·36	1·82	2·0	2·22	2·35	2·52	2·62	2·75	2·88	2·96
300	1·29	1·62	1·91	2·08	2·22	2·35	2·52	2·62	2·71	2 80
350	1·26	1·59	1·82	2 0	2·15	2·29	2·35	2·46	2·57	2·67
400	1·18	1·49	1·71	1·91	2·0	2·15	2·29	2·35	2·46	2·57
500	1·08	1·44	1·59	1·83	1·91	2·0	2·15	2·22	2·29	2·35
600	1·03	1·29	1·48	1·64	1·82	1·91	2·0	2·08	2·15	2·22

Vide Molesworth.

The relative power to resist torsion of steel being 1·95 taking wrought-iron as 1, it will be easy to obtain the diameters for steel shafting by dividing any of the above tables by 1·95.

Harper's give the following short rule :—

Steel Shafting	1½	2	2½	3	3½	4	4½	5	5½	6 inches diameter.
Will transmit	½	1⅛	2¼	3⅝	6	9	13	18	24	31 horse-power

for every ten revolutions per minute.

SHAFTING AND GEARING—*Continued.*

TABLE OF DISTANCES APART OF BEARINGS, CENTRE TO CENTRE.

Diam. of Shaft in ins.	Centres	Diam. of Shaft in ins.	Centres	Diam. of shaft in ins.	Centres	Diam. of shaft in ins.	Centres
1	5·0	$2\frac{3}{4}$	9·9	$4\frac{1}{2}$	13·6	$7\frac{1}{2}$	19·0
$1\frac{1}{4}$	5·9	3	10·3	$4\frac{3}{4}$	14·0	8	20·0
$1\frac{1}{2}$	6·6	$3\frac{1}{4}$	11·0	5	14·6	$8\frac{1}{2}$	20·9
$1\frac{3}{4}$	7·3	$3\frac{1}{2}$	11·6	$5\frac{1}{2}$	15·6	9	21·6
2	8·0	$3\frac{3}{4}$	12·0	6	16·6	10	23·3
$2\frac{1}{4}$	8·6	4	12·6	$6\frac{1}{2}$	17·6	11	24·9
$2\frac{1}{2}$	9·3	$4\frac{1}{4}$	13·0	7	18·3	12	26·3

The above table is calculated from the following formula :—

$$\text{Centres} = 5\sqrt[3]{\text{diameter of shaft in inches}^{\,2}}$$

TO FIND THE POWER OF SPUR GEARING.

RULE.—The square of the pitch of the teeth in inches × the breadth of the teeth in inches = the H.P. the teeth are equal to when travelling at a pitch line speed of 17 feet per minute.

ANOTHER RULE.—The square of the pitch in inches × speed in feet per minute × breadth of the teeth and divide by 1000 = the H.P. which can be transmitted.

Harper's give the following :—

A Gear wheel having													
	ordinary teeth	2	3	4	5	6	7	8	9	10	11	12	inches broad
	and of	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$	,, pitch
	will transmit	$\frac{3}{16}$	$\frac{5}{16}$	$1\frac{1}{8}$	2	$3\frac{1}{8}$	$4\frac{1}{2}$	$6\frac{1}{4}$	$8\frac{1}{8}$	$11\frac{1}{4}$	$14\frac{3}{4}$	19	H.P. if spur
	or	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{7}{8}$	$1\frac{1}{2}$	$2\frac{3}{8}$	$3\frac{1}{2}$	$4\frac{7}{8}$	$6\frac{1}{2}$	$8\frac{1}{2}$	11	14	H.P. if bevel

For every 100 feet of circumference velocity per minute.

Double flanged wheels are $\frac{1}{3}$ more powerful.

Helical teeth are $\frac{1}{5}$ stronger.

Mortice teeth $\frac{1}{4}$ weaker than ordinary teeth.

RELATIVE PITCHES OF TEETH OF EQUAL STRENGTH FOR DIFFERENT MATERIAL.

Material	Relative Pitch
Cast Iron ..	1·0
Wrought Iron ..	0 6
Steel ..	0·5
Wood ..	1·4
Gunmetal ..	1·3

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